Pearson

Pearson BTEC
International Level 3 in

Applied Science

L3

Specification

First teaching from September 2027

Issue 1

Pearson

Pearson BTEC International Level 3 Qualifications in Applied Science

Specification

First teaching September 2027

First certification from 2029

Issue 1

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 learners, educational institutions, employers, governments and other partners globally. We are committed to helping equip learners 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.

VQ000537

All the material in this publication is copyright
© Pearson Education Limited 2026

Welcome

With a track record built over 40 years of student success, our BTEC International Level 3 qualifications are recognised internationally by governments, industry and higher education. BTEC International Level 3 qualifications allow students to progress to the workplace – either directly or via study at a higher level. Over 100,000 BTEC students apply to university every year. Their Level 3 BTECs, either on their own or in combination with A Levels, are accepted by UK and international universities, and higher-education institutes for entry to relevant degree programmes.

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 assignments. They enable the holistic development of the practical, interpersonal and thinking skills required to succeed in higher education and employment.

When creating these BTEC Internationals 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 12 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 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.

Collaborative development

Students who complete their BTEC International Level 3 qualification in Applied Science aim to go on to employment, often via the stepping stone of higher education. It was, therefore, essential that we developed these qualifications in close collaboration with experts from professional bodies, universities and with the providers who will be delivering the qualifications. We engaged experts in the development of these qualifications to ensure that the content meets providers' needs and gives learners quality preparation to help them progress. We are grateful to all the university and further-education lecturers, teachers, professional body representatives and other individuals who have generously shared their time and expertise to help us develop these new qualifications.

Employers, professional bodies and higher-education providers that have worked with us include:

- Mahatma Gandhi International School
- Manchester Metropolitan University
- NPTC Group.

Collaborative partners have provided letters of support confirming that these qualifications meet their entry requirements. The letters can be viewed on our website: qualifications.pearson.com.

A word to students

Today's BTEC Internationals will require commitment and hard work, as you would expect of the most respected applied learning qualification in the world. You will have to complete a range of units, be organised, take some assessments that we will set and your teachers will 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 or go on to work – your BTEC International 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 International Level 3 Qualifications in Applied Science?

We've listened to feedback from all parts of the 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 Science environment – qualifications that enable your students to apply themselves and give them the skills to succeed in their chosen pathway.

The units focus on developing knowledge, understanding and practical skills relevant to science as applied to the modern world. Key features include hands-on research tasks, collaborative group work, and reflective practice. Assessments are varied and designed to test both technical proficiency and critical thinking. Evidence of achievement can be through written reports, presentations, peer reviews, and/or live demonstrations.
Each unit encourages learners to apply concepts to real-world scenarios, fostering deeper understanding. Assessment also emphasises communication, planning and evaluation, aligning with higher education and industry expectations.

Total Qualification Time

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 internal assessment under 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 Internationals have been designed around the number of hours of guided learning expected. Each unit in the qualification has a GLH value of 60. 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 International Level 3 Certificate in Applied Science	180 GLH (30 Credits) (390 TQT) Equivalent in size to 0.5 of an International A Level. Three mandatory units which are assessed by Pearson Set Assignments. Mandatory content (100%).	The Certificate is for students who want an introduction to the sector through applied learning and for whom an element of applied science would be complementary. The qualification supports progression to higher education as part of a programme of study that includes other appropriate BTEC International Level 3 qualifications or International A Levels.

Qualification title	Size and structure	Summary purpose
Pearson BTEC International Level 3 Extended Certificate in Applied Science	360 GLH (60 Credits) (785 TQT) Equivalent in size to one International A Level. Six units of which three are mandatory, up to six could be assessed by a Pearson Set Assignment. Mandatory content (50%).	The Extended Certificate is for students who are interested in learning about science-related industries alongside other fields of study, with a view to progressing to a wide range of higher education courses, not necessarily in science-related subjects. The qualification is designed to be taken as part of a programme of study that includes other appropriate BTEC International Level 3 qualifications or International A Levels.
Pearson BTEC International Level 3 Foundation Diploma in Applied Science	540 GLH (90 Credits) (1205 TQT) Equivalent in size to 1.5 International A Levels. Nine units of which five are mandatory, up to seven could be assessed by a Pearson Set Assignment. Mandatory content (56%).	The Foundation Diploma is for students who want to study applied science as a one-year, full-time course, or for those wanting to take it alongside another area of complementary or contrasting study as part of a two-year, full-time study programme. The qualification would support progression to higher education if taken as part of a programme of study that included other BTEC International Level 3 qualifications or International A Levels.

Qualification title	Size and structure	Summary purpose
Pearson BTEC International Level 3 Diploma in Applied Science	720 GLH (120 Credits) (1620 TQT) Equivalent in size to two International A Levels. Twelve units of which seven are mandatory, up to eight could be assessed by a Pearson Set Assignment. Mandatory content (58%).	The Diploma is for students who want to study applied science as the main element alongside another area of complementary or contrasting study as part of a two-year, full-time study programme. The qualification would support progression to higher education if taken as part of a programme of study that included other BTEC International Level 3 qualifications or International A Levels.
Pearson BTEC International Level 3 Extended Diploma in Applied Science	1080 GLH (180 Credits) (2430 TQT) Equivalent in size to three International A Levels. Eighteen units of which eleven are mandatory, eight are assessed by a Pearson Set Assignment. Mandatory content (61%).	The Extended Diploma is a full-time course for students who want to study applied science as the main focus of a two-year, full-time study programme. The qualification would support progression to higher education in its own right. This qualification could also directly lead to employment in Level 3 roles in science-related sectors or higher-education courses.

Structures of the qualifications at a glance

This table shows all the units and the qualifications to which they contribute. The full structure for these Pearson BTEC International Level 3 Qualifications in Applied Science is shown in *Section 3 Structure*. **You must refer to the full structure to select units and plan your programme.**

Key

Pearson Set Assignment units are shown in bold

M	Mandatory units	O	Optional units

Unit	Unit size (GLH)	Certificate (180 GLH)	Extended Certificate (360 GLH)	Foundation Diploma (540 GLH)	Diploma (720 GLH)	Extended Diploma (1080 GLH)
1 **Principles and Applications of Biology**	60	M	M	M	M	M
2 **Principles and Applications of Chemistry**	60	M	M	M	M	M
3 **Principles and Applications of Physics**	60	M	M	M	M	M
4 **Real-World Scientific Mathematics**	60				M	M
5 **Contemporary Science Issues**	60				M	M
6 **Health Challenges and Medical Innovations**	60		O	O	O	M
7 **Chemical Principles and Reaction Systems**	60		O	O	O	M
8 **Physics for Energy, Materials and Communication**	60		O	O	O	M

Unit	Unit size (GLH)	Certificate (180 GLH)	Extended Certificate (360 GLH)	Foundation Diploma (540 GLH)	Diploma (720 GLH)	Extended Diploma (1080 GLH)
9 Practical Scientific Procedures and Techniques	60		O	M	M	M
10 Investigative Science Project	60			M	M	M
11 Energy Generation Challenges and Opportunities	60					M
12 Electrical Circuits and Measurement	60		O	O	O	O
13 Human Disease, Infection and Environmental Health	60		O	O	O	O
14 Biochemical Processes and Pathways in Living Organisms	60		O	O	O	O
15 Applications of Physical, Inorganic and Organic Chemistry	60		O	O	O	O
16 Human Body Systems: Physiology, Disorders and Health Solutions	60				O	O
17 Medical Instrumentation Techniques for Diagnosis and Therapy	60			O	O	O
18 Modern Materials and Sustainable Technologies	60			O	O	O
19 Atmospheric Science and Climate Change	60					O
20 Human Body Systems: Regulation, Control, and Reproduction	60					O

Unit	Unit size (GLH)	Certificate (180 GLH)	Extended Certificate (360 GLH)	Foundation Diploma (540 GLH)	Diploma (720 GLH)	Extended Diploma (1080 GLH)
21 Genetics and Biotechnology Principles, Techniques and Applications	**60**					**O**
22 Environmental Pollution and Sustainable Waste Management	**60**					**O**

Qualification and unit content

Pearson has developed the content of the new BTEC Internationals 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, 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 in, 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. All assessment is internal but some mandatory units have extra controls on assessment and are assessed using Pearson Set Assignments.

Pearson Set Assignment (PSA) units

Some units in these qualifications are assessed using a Pearson Set Assignment Brief (PSAB), which is set by Pearson and is marked by teachers. The teachers will make grading decisions based on the requirements and supporting guidance given in the units.

Pearson Set Assignment units are subject to external standards verification processes common to all BTEC units. By setting the assignment for some units, we can ensure that all students take the same set of assessments for a specific unit. For further information on preparing for Pearson Set Assignments, see the *Pearson BTEC International Level 3 Qualifications Supplementary Information* document which is available on our website.

Internally assessed units

All units in these qualifications are internally assessed and subject to external standards verification. In some units, Pearson will set the assessments using Pearson Set Assignments, which are marked by you. In other units, you set and assess the assignments that provide the final summative assessment for each unit, using the examples and support that Pearson provides. 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 the *Pearson BTEC International Level 3 Qualifications Supplementary Information* document, which is available on our website.

For units where there is no Pearson Set Assignment, you select the most appropriate assessment styles according to the learning set out in the unit. This ensures that students are assessed using a variety of styles to help them develop a broad range of transferable skills. Students could be given opportunities to:

- write up the findings of their own research
- use case studies to explore complex or unfamiliar situations
- carry out projects for which they have choice over the direction and outcomes
- demonstrate practical and technical skills using appropriate tools/processes, etc.

For these units, Pearson will provide an Authorised Assignment Brief (AAB) that you can use.

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 can be of a task or subset of the assignment brief that is of evidence in a new or revised form. The deadline for submission of the retake must fall within the same academic year.

Language of assessment

Assessment of the units for these qualifications will be available in English but can be translated as necessary. A student taking the qualifications may be assessed in sign language where it is permitted for the purpose of reasonable adjustment.

For information on reasonable adjustments see the *Pearson BTEC International Level 3 Qualifications Specification Supplementary Information* document, which is available on our website.

Grading for units and qualifications

Achievement in a 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) and Unclassified (U). All mandatory and optional units contribute proportionately to the overall qualification grade.

BTEC International 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.

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 these qualifications. 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 and 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. **Interpersonal skills**: (1) Written communication; (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 these qualifications 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 do not 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 student progression is available in the *BTEC Transferable Skills Guide for Teachers.*

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 the Institute for Apprenticeships and Technical Education (IFATE) as a frame of reference to identify opportunities for the delivery and development of digital skills in this qualification.

The *Digital Skills Framework* for these qualifications has five categories with specific digital characteristics that apply in varying extent across sectors:

1. **Problem solving** – The use of digital tools to analyse and solve problems
2. **Digital collaboration and communication** – Using digital tools to communicate and share information with stakeholders
3. **Transacting digitally** – Using digital tools to set up accounts and pay for goods/services
4. **Digital security** – Identify threats and keep digital tools safe
5. **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:

- 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 exist in these qualifications.

Sustainability skills

To help students develop sustainability skills, practices and mindset, we have designed content in these qualifications, 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 and provides a useful and pragmatic way of organising 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 the sustainability skills, knowledge or 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 has been included in these qualifications.

2 Qualification purpose

Pearson BTEC International Level 3 Qualifications in Applied Science

In this section, you will find information on the purpose of these qualifications and how their design meets that purpose through the qualification' objectives and structures.

Who are these qualifications for?

The Pearson BTEC International Level 3 qualifications in science are designed either for students in the 16–19 age group, who wish to pursue a career in science via higher education to access graduate entry employment with businesses, or alternatively through junior employment.

Which size qualification to choose?

Choosing the most suitable size of qualification will depend on the student's broader programme of study. For example, a student who wishes to focus solely on applied science may take the Diploma or Extended Diploma, while a student who selects a smaller qualification, such as the Certificate or Extended Certificate, may choose to combine it with qualifications from other sectors, to support their desired progression. Smaller qualifications are also suitable for students who are in employment and studying part-time.

Qualification structures have been designed to enable a student who starts with the smallest qualification to progress easily to the larger qualifications.

What do these qualifications cover?

The content of these qualifications has been designed to support progression to particular roles in science and science-related sectors, either directly into entry-level roles linked to these occupational areas or, more likely, via particular higher-education routes in the particular areas. The qualification content has been designed in consultation with employers, professional bodies and higher-education providers to ensure that the content is appropriate for the progression routes identified.

All students will be required to take mandatory content that is directly relevant to progression routes in all of the identified areas.

In addition, students take optional units that support the progression route identified in the qualification title.

For example, students taking the qualification as part of a work-based learning environmental or sustainable science qualification could take units such as:

- Unit 11: Energy Generation Challenges and Opportunities
- Unit 19: Atmospheric Science and Climate Change: Evidence, Impacts and Solutions
- Unit 22: Environmental Pollution and Sustainable Waste Management.

Students taking the qualification as part of a healthcare or medicine route could take units such as:

- Unit 13: Human Disease, Infection and Environmental Health
- Unit 14: Biochemical Processes and Pathways in Living Organisms
- Unit 16: Human Body Systems: Physiology , Disorders and Health Solutions
- Unit 20: Human Body Systems: Regulation, Control and Reproduction
- Unit 21: Genetics and Biotechnology Principles, Techniques and Applications.

Students taking the qualification as part of a forensic or analytical science route could take units such as:

- Unit 9: Practical Scientific Procedures and Techniques
- Unit 15: Applications of Physical, Inorganic and Organic Chemistry
- Unit 17: Medical Instrumentation Techniques for Diagnosis and Therapy
- Unit 18: Modern Materials and Sustainable Technologies
- Unit 21: Genetics and Biotechnology Principles, Techniques and Applications.

Students taking the qualification as part of an engineering or applied physics route could take units such as:

- Unit 4: Real-World Scientific Mathematics
- Unit 11: Energy Generation Challenges and Opportunities
- Unit 12: Fundamentals of Electrical Circuits and Measurement
- Unit 17: Medical Instrumentation Techniques for Diagnosis and Therapy
- Unit 18: Modern Materials and Sustainable Technologies.

What could these qualifications lead to?

These qualifications support progression to job opportunities in science and science-related areas at a variety of levels. Jobs available in these areas include:

- Clinical research assistant
- Forensic technician
- Pharmacy assistant
- Biomedical engineer
- Environmental scientist
- Renewable energy technician.

After achieving this qualification, while students can progress directly to entry-level roles, it is likely that many will do so via higher study. These qualifications are recognised by higher education institutions worldwide and provides students with opportunities to progress into further and higher study across various areas within the science sector.

For example:

- Pearson BTEC Higher Nationals in Applied Sciences
- BSc (Hons) in Biomedical Science
- BSc (Hons) in Forensic Science
- BSc (Hons) in Climate and Environmental Sciences.

NB: students should always check the entry requirements for degree programmes with the relevant higher education provider.

3 Structure

Qualification structures

The structures for the qualifications in this specification are:

- Pearson BTEC International Level 3 Certificate in Applied Science (180 GLH)
- Pearson BTEC International Level 3 Extended Certificate in Applied Science (360 GLH)
- Pearson BTEC International Level 3 Foundation Diploma in Applied Science (540 GLH)
- Pearson BTEC International Level 3 Diploma in Applied Science (720 GLH)
- Pearson BTEC International Level 3 Extended Diploma in Applied Science (1080 GLH).

Pearson BTEC International Level 3 Certificate in Applied Science (180 GLH)

Students must complete 3 mandatory units.

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**	Set Assignment
2	Principles and Applications of Chemistry	**60**	**Mandatory**	Set Assignment
3	Principles and Applications of Physics	**60**	**Mandatory**	Set Assignment

Pearson BTEC International Level 3 Extended Certificate in Applied Science (360 GLH)

Students must complete 3 mandatory units and 3 optional units.

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**	Set Assignment
2	Principles and Applications of Chemistry	**60**	**Mandatory**	Set Assignment
3	Principles and Applications of Physics	**60**	**Mandatory**	Set Assignment

Optional units – students complete 3 units

Unit number	Unit title	GLH	Type	How assessed
6	Health Challenges and Medical Innovations	**60**	**Optional**	Set Assignment
7	Chemical Principles and Reaction Systems	**60**	**Optional**	Set Assignment
8	Physics for Energy, Materials and Communication	**60**	**Optional**	Set Assignment
9	Practical Scientific Procedures and Techniques	**60**	**Optional**	Internal
12	Electrical Circuits and Measurement	**60**	**Optional**	Internal
13	Human Disease, Infection and Environmental Health	**60**	**Optional**	Internal
14	Biochemical Processes and Pathways in Living Organisms	**60**	**Optional**	Internal
15	Applications of Physical, Inorganic and Organic Chemistry	**60**	**Optional**	Internal

Pearson BTEC International Level 3 Foundation Diploma in Applied Science (540 GLH)

Students must complete 5 mandatory units and 4 optional units.

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**	Set Assignment
2	Principles and Applications of Chemistry	**60**	**Mandatory**	Set Assignment
3	Principles and Applications of Physics	**60**	**Mandatory**	Set Assignment
9	Practical Scientific Procedures and Techniques	**60**	**Mandatory**	Internal
10	Investigative Science Project	**60**	**Mandatory**	Internal

Optional units – students complete 4 units

Unit number	Unit title	GLH	Type	How assessed
6	Health Challenges and Medical Innovations	**60**	**Optional**	Set Assignment
7	Chemical Principles and Reaction Systems	**60**	**Optional**	Set Assignment
8	Physics for Energy, Materials and Communication	**60**	**Optional**	Set Assignment
12	Electrical Circuits and Measurement	**60**	**Optional**	Internal
13	Human Disease, Infection and Environmental Health	**60**	**Optional**	Internal
14	Biochemical Processes and Pathways in Living Organisms	**60**	**Optional**	Internal
15	Applications of Physical, Inorganic and Organic Chemistry	**60**	**Optional**	Internal
17	Medical Instrumentation Techniques for Diagnosis and Therapy	**60**	**Optional**	Internal
18	Modern Materials and Sustainable Technologies	**60**	**Optional**	Internal

Pearson BTEC International Level 3 Diploma in Applied Science (720 GLH)

Students must complete 7 mandatory units and 5 optional units.

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**	Set Assignment
2	Principles and Applications of Chemistry	**60**	**Mandatory**	Set Assignment
3	Principles and Applications of Physics	**60**	**Mandatory**	Set Assignment
4	Real-World Scientific Mathematics	**60**	**Mandatory**	Set Assignment
5	Contemporary Science Issues	**60**	**Mandatory**	Set Assignment
9	Practical Scientific Procedures and Techniques	**60**	**Mandatory**	Internal
10	Investigative Science Project	**60**	**Mandatory**	Internal

Optional units – students complete 5 units

Unit number	Unit title	GLH	Type	How assessed
6	Health Challenges and Medical Innovations	**60**	**Optional**	Set Assignment
7	Chemical Principles and Reaction Systems	**60**	**Optional**	Set Assignment
8	Physics for Energy, Materials and Communication	**60**	**Optional**	Set Assignment
12	Electrical Circuits and Measurement	**60**	**Optional**	Internal
13	Human Disease, Infection and Environmental Health	**60**	**Optional**	Internal
14	Biochemical Processes and Pathways in Living Organisms	**60**	**Optional**	Internal
15	Applications of Physical, Inorganic and Organic Chemistry	**60**	**Optional**	Internal
16	Human Body Systems: Physiology, Disorders and Health Solutions	**60**	**Optional**	Internal
17	Medical Instrumentation Techniques for Diagnosis and Therapy	**60**	**Optional**	Internal
18	Modern Materials and Sustainable Technologies	**60**	**Optional**	Internal

Pearson BTEC International Level 3 Extended Diploma in Applied Science (1080 GLH)

Students must complete all mandatory units and seven optional units.

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**	Set Assignment
2	Principles and Applications of Chemistry	**60**	**Mandatory**	Set Assignment
3	Principles and Applications of Physics	**60**	**Mandatory**	Set Assignment
4	Real-World Scientific Mathematics	**60**	**Mandatory**	Set Assignment
5	Contemporary Science Issues	**60**	**Mandatory**	Set Assignment
6	Health Challenges and Medical Innovations	**60**	**Mandatory**	Set Assignment
7	Chemical Principles and Reaction Systems	**60**	**Mandatory**	Set Assignment
8	Physics for Energy, Materials and Communication	**60**	**Mandatory**	Set Assignment
9	Practical Scientific Procedures and Techniques	**60**	**Mandatory**	Internal
10	Investigative Science Project	**60**	**Mandatory**	Internal
11	Energy Generation Challenges and Opportunities	**60**	**Mandatory**	Internal

Optional units – students complete 7 units

Unit number	Unit title	GLH	Type	How assessed
12	Electrical Circuits and Measurement	**60**	**Optional**	Internal
13	Human Disease, Infection and Environmental Health	**60**	**Optional**	Internal
14	Biochemical Processes and Pathways in Living Organisms	**60**	**Optional**	Internal
15	Applications of Physical, Inorganic and Organic Chemistry	**60**	**Optional**	Internal
16	Human Body Systems: Physiology, Disorders and Health Solutions	**60**	**Optional**	Internal
17	Medical Instrumentation Techniques for Diagnosis and Therapy	**60**	**Optional**	Internal
18	Modern Materials and Sustainable Technologies	**60**	**Optional**	Internal
19	Atmospheric Science and Climate Change	**60**	**Optional**	Internal
20	Human Body Systems: Regulation, Control and Reproduction	**60**	**Optional**	Internal
21	Genetics and Biotechnology Principles, Techniques and Applications	**60**	**Optional**	Internal
22	Environmental Pollution and Sustainable Waste Management	**60**	**Optional**	Internal

Pearson Set Assignment units

This is a summary of the type and availability of Pearson Set Assignment units. For further information on preparing for Pearson Set Assignments, see the *Pearson BTEC International Level 3 Qualifications Supplementary Information* document which is available on our website.

Unit	Type	Availability
Unit 1: Principles and Applications of Biology	An assignment set by Pearson and marked by the centre. The advised period is 20 hours.	**Single PSA**
Unit 2: Principles and Applications of Chemistry	An assignment set by Pearson and marked by the centre. The advised period is 20 hours.	**Single PSA**
Unit 3: Principles and Applications of Physics	An assignment set by Pearson and marked by the centre. The advised period is 20 hours.	**Single PSA**
Unit 4: Real-World Scientific Mathematics	An assignment set by Pearson and marked by the centre. The advised period is 3 hours.	**Single PSA**
Unit 5: Contemporary Science Issues	An assignment set by Pearson and marked by the centre. The advised period is 10 hours.	**Bank PSA**
Unit 6: Health Challenges and Medical Innovations	An assignment set by Pearson and marked by the centre. The advised period is 6 hours.	**Bank PSA**
Unit 7: Chemical Principles and Reaction Systems	An assignment set by Pearson and marked by the centre. The advised period is 6 hours.	**Bank PSA**
Unit 8: Physics for Energy, Materials and Communication	An assignment set by Pearson and marked by the centre. The advised period is 6 hours.	**Bank PSA**

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.

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.

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 at Level 3.
Unit type	This confirms that the unit is internal or assessed using a Pearson Set Assignment. See structure information in *Section 3 Structure* for full details.
GLH	Units have a Guided Learning Hours (GLH) value of 60. This indicates the numbers 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 you 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 the unit. The key helps to identify whether they are signposted but require additional assessment, embedded and achieved on completion, or not present in the 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 (PSAB). Centres must download and use the mandatory PSAB without alteration or contextualisation.
Essential information for assignments	This section gives you information to support the implementation of assessment. It is important that this is read carefully alongside the assessment criteria, as the information will help with interpretation of the requirements.
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 assignment.
Resource requirements	Any specific resource requirements that you need to be able to teach and assess are listed in this section.
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.

Section	Explanation
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: Pearson Set Assignment

Guided learning hours: 60

Unit in brief

The unit covers the structure and function of cells, tissues and biological molecules. It also explores membrane transport, enzyme activity and homeostatic regulation, linking molecular mechanisms to whole-body function and health.

Unit introduction

This unit connects directly to real-world work in healthcare, biotechnology and life sciences. Knowledge of cells, tissues and biological molecules supports careers in medicine, diagnostics and research. It enables students to interpret biological processes, understand disease mechanisms and apply scientific principles. The unit also strengthens analytical and problem-solving abilities essential for evidence-based scientific practice.

In this unit, you will study the ultrastructure of prokaryotic and eukaryotic cells, specialised cells and biological tissues. You will investigate the structure and roles of major biomolecules, including carbohydrates, proteins, lipids, nucleic acids and water. Additionally, you will explore transport mechanisms, enzyme activity and homeostatic systems, linking molecular detail to whole-body function and health.

Completing this unit supports progression into higher education in biology, biomedical sciences and healthcare fields. It also provides a strong basis for careers in laboratory work, clinical support and the pharmaceutical industry. The knowledge and skills gained help students prepare for advanced study and professional practice, building confidence in applying biological concepts to real-world challenges.

Learning aims

In this unit, you will:

A Understand the structure and function of cells and tissues as the foundation of how organisms work

B Explore the structure and function of biological molecules and the roles they play in health and disease

C Examine the relationship between homeostasis, cellular transport methods and enzyme activity.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Understand the structure and function of cells and tissues as the foundation of how organisms work	**A1** Structure and function of cells and tissues **A2** Structure and function of specialised cells in multicellular organisms **A3** Structure and function of biological tissues	Pearson Set Assignment.
B Explore the structure and function of biological molecules and the roles they play in health and disease	**B1** Structure and function of water **B2** Structure and function of carbohydrates **B3** Structure and function of proteins **B4** Structure and function of nucleic acids **B5** Structure and function of lipids	
C Examine the relationship between homeostasis, cellular transport methods and enzyme activity	**C1** Cell transport mechanisms **C2** Enzymes as biological catalysts **C3** Homeostasis	

Content

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

Learning aim A: Understand the structure and function of cells and tissues as the foundation of how organisms work [EL – MOL]

A1 Structure and function of cells and tissues

- Cell theory:
  - unifying concept of cells as a fundamental unit of structure, function and organisation in all living organisms
  - relationship between cells, tissues and organs
  - importance of stem cells.
- Ultrastructure and function of organelles in the following cells:
  - prokaryotic cells (bacterial cells):
    - nucleoid
    - plasmids
    - 70S ribosomes
    - capsule
    - cell wall
    - plasma membrane
    - flagella
    - pili
    - cytoplasm
  - eukaryotic cells:
    - plasma membrane
    - cytoplasm
    - nucleus
    - nucleolus
    - endoplasmic reticulum (smooth and rough)
    - Golgi apparatus
    - vesicles
    - lysosomes
    - 80S ribosomes
    - mitochondria
    - centrioles
    - cilia

- plant-cell-specific organelles:
  - cell wall
  - chloroplasts
  - vacuole
  - tonoplast
  - amyloplasts
  - plasmodesmata
  - pits

- Recognising organelles from electron micrographs and photomicrographs.
- Similarities and differences between the structure and function of plant cells and animal cells.
- Differences in Gram-positive and Gram-negative bacteria structure and the implications for antibiotic treatments.
- Testing to distinguish between Gram-positive and Gram-negative bacteria.
- Calculation of magnification and size of cells and organelles from images.
- Mathematical skills:
  - Magnification calculating cell size from images:

$$\frac{\text{Image size}}{\text{Actual size}}$$

  - Surface Area = $6a^2$: Volume = a^3 to give cell efficiency

$$\frac{6a^2}{a^3}$$

A2 Structure and function of specialised cells in multicellular organisms

- Structure and function of specialised eukaryotic cells:
  - 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

- Structure and function of epithelial tissue:
  - squamous, including the role of alveolar epithelium in gas exchange
  - columnar, including goblet cells and ciliated cells in the lungs, to include their role in protecting the lungs from pathogens
  - how damage to these tissues leads to chronic obstructive pulmonary disease (COPD).

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

- Structure and function of endothelial tissue as illustrated by blood vessels in the cardiovascular system:
  - risk factors that damage endothelial cells and lead to the development of atherosclerosis.
- Structure and function of muscular tissue:
  - microscopic structure of a skeletal muscle fibre
  - structural and functional differences between fast- and slow-twitch muscle fibres and their relevance to short-term and endurance-based activities.
- Structure and function of nervous tissue:
  - non-myelinated and myelinated neurones
  - the conduction of a nerve impulse along an axon, to include changes in membrane permeability to sodium and potassium ions and the role of myelination in saltatory conduction
  - interpretation of graphical displays of a nerve impulse
  - synaptic structure and the role of neurotransmitters
  - imbalances of brain chemicals that can contribute to ill health, including dopamine in Parkinson's disease
  - effects of drug interactions on synaptic transmission, to include agonists, antagonists and precursors.
- Structure and function of plant tissues:
  - photosynthesis and crop productivity
  - water transport and drought response
  - transport tissues and nutrient allocation.

Learning aim B: Explore the structure and function of biological molecules and the roles they play in health and disease

B1 Structure and function of water

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

- Structure:
  - contain carbon (C), hydrogen and oxygen atoms
  - monosaccharides:
    - alpha (α) and beta (β) glucose
    - galactose
    - fructose
    - ribose and deoxyribose
  - disaccharides:
    - lactose
    - maltose
    - sucrose
  - polysaccharides
    - starch (amylose and amylopectin)
    - cellulose
    - glycogen
  - polysaccharide structure with bonds made through condensation reactions.
- Function:
  - release of energy and the production of ATP
  - energy storage
  - structural
  - use of iodine and Benedict's solution as tests for presence of carbohydrates:
    - calculating Concentration:

$$\frac{\text{Mass}}{\text{Volume}}$$

    - calculating composition Percentage:

$$\frac{\text{Part}}{\text{Whole}} \text{x} 100$$

B3 Structure and function of proteins

- Structure:
    - contain carbon, hydrogen, oxygen and nitrogen (N) atoms
    - monomers are amino acids
    - there are 20 different amino acids with different R groups
    - primary structure, including the peptide bond, to give polypeptides
    - secondary structure, including α-helices and β-pleated sheets
    - tertiary structure:
        - ionic bond
        - hydrogen bonding
        - disulfide bridges/bonds
        - van der Waals forces
    - quaternary structure, including haemoglobin
    - classification as globular or fibrous.
- Function:
    - muscles
    - enzymes
    - antibodies
    - antigens
    - channel, pump and carrier proteins
    - hormones
    - for transport of other components
    - body tissue growth and repair
    - blood clotting.
- Use of Biuret solution as a test for the presence of protein.

B4 Structure and function of nucleic acids

- Structure:
    - contain carbon, hydrogen, oxygen, nitrogen and phosphorus (P) atoms
    - 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 single strand of RNA using DNA as a template
    - differences in structure and function of rRNA, mRNA and tRNA.

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

B5 Structure and function of lipids

- Structure:
  - carbon, hydrogen and oxygen in fats, oils and waxes
  - saturated and unsaturated fats, and formation of diglycerides and triglycerides via esterification reactions.
- Function:
  - energy sources and stores
  - insulation and organ protection
  - phospholipids in membranes
  - steroid hormones.
- Use of emulsion tests to identify presence of lipids.

Learning aim C: Examine the relationship between homeostasis, cellular transport methods and enzyme activity

C1 Cell transport mechanisms

- Structure of the cell surface membrane with reference to the fluid mosaic model.
- Methods used to transport molecules through cell membranes:
  - passive transport
    - diffusion
    - facilitated diffusion
    - osmosis
  - active methods
    - active transport
  - bulk transport
    - endocytosis
    - exocytosis
- Significance of surface area to volume ratio in living organisms.

C2 Enzymes as biological catalysts

- Structure:
  - made of proteins
  - active site with specific tertiary structure.

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

$$\frac{\text{Change in quantity}}{\text{Time}}$$

- Factors affecting enzyme activity:
  - temperature
  - pH
  - substrate and enzyme concentration
  - optimum
  - denaturing.
- Interpretation of graph axes, units and trends.
- Calculation of rate gradients:

$$\text{Gradient} = \frac{\text{Change in y}}{\text{Change in x}}$$

C3 Homeostasis

- The purpose of homeostasis in relation to:
  - optimum conditions
  - stimulus
  - receptors/sensors
  - control centres
  - effectors
  - feedback.
- Negative feedback loops affecting the body:
  - blood pressure
  - body fluids (osmoregulation)
  - gas concentration
  - blood sugar levels.
- Positive feedback loops affecting the body:
  - blood clotting
  - labour contractions.

- Interrelationship between nervous and endocrine system responses:
  - role of the autonomic nervous system in controlling breathing and heart rate
  - role of adrenal glands and the fight-or-flight response
  - hypothalamus as the link between the endocrine and nervous systems.
- Disturbance of homeostasis:
  - ageing, weakening of feedback loops, heart failure, diabetes
  - influence of lifestyle on homeostasis:
    - impact of diet and nutrition on energy availability, blood glucose regulation and electrolyte balance
    - effect of sedentary lifestyle on the cardiovascular system
    - drug/alcohol abuse affecting liver function, blood pressure regulation and hormonal balance
    - how psychological stress and mental health conditions can disrupt hormonal and physiological responses

Assessment criteria

Learning aim A: Understand the structure and function of cells and tissues as the foundation of how organisms work

Pass	Merit	Distinction
A.P1 Describe the ultrastructure and functions of prokaryotic and eukaryotic organelles using appropriate terminology. **A.P2** Explain specialised cell structures and functions in multicellular organisms with reference to adaptations for reproduction and transport.	**A.M1** Explain similarities and differences in structure and function between animal, plant and specialised eukaryotic cells.	**A.D1** Analyse how structural variations in plant and animal tissues and cells enable efficient physiological function and responses to disease.

Learning aim B: Explore structure and function of biological molecules and the roles they play in health and disease

Pass	Merit	Distinction
B.P3 Describe the structure and function of water, carbohydrates, proteins, lipids and nucleic acids in organisms. **B.P4** Describe biochemical tests for carbohydrates, proteins and lipids, linked to clarity of implementation.	**B.M2** Explain how the molecular structure of carbohydrates, proteins and nucleic acids relates to their biochemical test and specific biological roles.	**B.D2** Evaluate the significance of molecular properties in physiological processes, justifying their roles in health.

Learning aim C: Examine the relationship between homeostasis, cellular transport methods and enzyme activity

Pass	Merit	Distinction
C.P5 Explain cell membrane structure and transport mechanisms, including diffusion, osmosis, active and bulk transport. **C.P6** Describe enzyme structure, function and the effects of temperature, pH and concentration on enzyme-controlled reactions.	**C.M3** Explain how cellular transport, enzyme action, and feedback mechanisms support homeostasis and maintain optimal internal conditions.	**C.D3** Evaluate interrelationships between nervous and endocrine systems, justifying responses to stress and lifestyle influences.

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 a part of wider teaching and learning
√	Embedded in teaching, learning and assessment
blank	Not embedded or signposted in unit

Essential information for Pearson Set Assignment (PSA)

Pearson sets the assignment for the assessment of this unit.

The PSA will take 20 hours to complete.

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

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

Assessing the PSA

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

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

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- Microscopes and prepared slides – light and electron micrographs for observing cell structures, tissues and specialised cells.
- Molecular model kits and diagrams – to illustrate structures of carbohydrates, proteins, lipids, nucleic acids and water molecules.
- Laboratory equipment and reagents – for biochemical tests, enzyme activity experiments and demonstrations of transport mechanisms.
- Digital resources and simulations – interactive animations, virtual labs and videos explaining homeostasis, nerve impulses and feedback systems.

Essential information for assessment decisions

Learning aim A

For distinction standard, students provide a detailed analysis of how structural variations in cells and tissues underpin physiological efficiency and responses to disease. Evidence includes evaluation of how features, such as myelination in neurons or fast-twitch muscle fibres, contribute to specialised functions. Students justify the significance of adaptations in maintaining health, referencing examples like dopamine imbalance in Parkinson's disease or endothelial damage in cardiovascular conditions. Students' work integrates graphical interpretation and considers the impact of drug interactions on cellular processes. Evidence should also include an evaluation of plant tissues in relation to their structural adaptations and functional roles in photosynthesis, water transport and nutrient allocation, with reference to how these processes influence crop productivity and drought resilience. Responses are critical and evaluative, demonstrating a sophisticated understanding of the interplay between structure, function and pathology in multicellular organisms.

For merit standard, students interpret similarities and differences in cell and tissue structure with greater insight, comparing features across animal, plant and specialised cells. They explain how adaptations support specific functions, such as gas exchange in alveolar epithelium or transport in phloem. Evidence includes reasoned comparisons and the use of examples to illustrate physiological relevance. Students discuss the impact of disease or external factors, such as COPD or atherosclerosis, on tissue function. Their work demonstrates the ability to link structural features to functional outcomes, showing a broader understanding of biological systems. Responses are analytical, with students drawing connections between cell specialisation and organismal efficiency.

For pass standard, students at this level demonstrate a foundational grasp of cell and tissue structure by accurately identifying and describing key organelles in both prokaryotic and eukaryotic cells. Evidence includes clear use of scientific terminology and recognition of organelles in micrographs. Students show understanding of specialised cell adaptations for reproduction and transport, referencing examples such as sperm, eggs and xylem cells. Their work demonstrates an ability to calculate magnification and cell size, and to distinguish between plant and animal cells. Students provide straightforward explanations of tissue types, such as epithelial and muscular, and can relate basic structural features to their functions. Their responses are factual and descriptive, showing a secure but limited depth of understanding.

Learning aim B

For distinction standard, students evaluate the significance of molecular properties in physiological processes, justifying their roles in health and homeostasis. Evidence includes critical discussion of how features such as polarity in water or quaternary structure in proteins underpin complex biological functions. Students justify the importance of molecular interactions in processes like enzyme activity, genetic expression or membrane formation. Their work integrates examples from health and disease, such as the impact of lipid composition on cardiovascular health or nucleic acid mutations in genetic disorders. Responses are evaluative, demonstrating a deep understanding of the relationships between molecular structure, function and physiological outcomes.

For merit standard, students explain how the molecular structures of carbohydrates, proteins and nucleic acids relate to their specific biological roles. Evidence includes reasoned accounts of how features such as hydrogen bonding in water or peptide links in proteins enable their functions. Students interpret the results of biochemical tests, linking outcomes to molecular properties. Their work demonstrates the ability to connect structure to function in a range of biological contexts, such as the role of cellulose in plant cell walls or haemoglobin in oxygen transport. Responses are analytical, with students providing examples that illustrate the relevance of molecular structure to biological activity.

For pass standard, students show secure knowledge of the basic structure and function of water, carbohydrates, proteins, lipids and nucleic acids. Evidence includes accurate descriptions of molecular components and their roles in organisms, such as energy storage or transport. Students can outline biochemical tests for these molecules, demonstrating practical understanding through clear procedural explanations. Their work is factual and demonstrates the ability to link molecular structure to general biological functions, such as the role of water in pH regulation or proteins in tissue repair. Responses are descriptive, showing competence in identifying and explaining key biochemical concepts.

Learning aim C

For distinction standard, students evaluate the interrelationships between nervous and endocrine systems, justifying responses to stress and lifestyle influences. Evidence includes critical analysis of how cellular transport and enzyme activity are regulated by hormonal and neural signals. Students discuss the impact of factors such as nutrition, physical activity and drug use on homeostasis, referencing examples like adrenaline release in fight-or-flight responses. Their work integrates knowledge of feedback mechanisms and physiological adaptation, demonstrating a sophisticated understanding of how cellular and systemic processes interact to maintain health. Responses are evaluative and justify the significance of integrated biological systems.

For merit standard, students explain how cellular transport, enzyme action and feedback mechanisms support homeostasis and maintain optimal internal conditions. Evidence includes reasoned accounts of how transport processes and enzyme specificity contribute to physiological regulation. Students discuss feedback loops, such as negative feedback in blood sugar control, and interpret the role of enzymes in metabolic pathways. Their work demonstrates the ability to link cellular processes to the maintenance of health, providing examples of how disruptions can lead to disease. Responses are analytical, showing a broader understanding of the integration of cellular mechanisms.

For pass standard, students provide clear explanations of cell membrane structure and transport mechanisms, including diffusion, osmosis, active transport and bulk transport. Evidence includes accurate descriptions of the fluid mosaic model and the significance of the surface area-to-volume ratio. Students describe enzyme structure and function, outlining how temperature, pH and concentration affect enzyme-controlled reactions. Their work demonstrates the ability to apply basic concepts to practical scenarios, such as interpreting results from enzyme experiments. Responses are factual and show a secure understanding of cellular transport and enzyme activity.

Links to other units

This unit gives underpinning knowledge, understanding and skills linked to:

- Unit 6: Health Challenges and Medical Innovations
- Unit 13: Human Disease, Infection and Environmental Health
- Unit 16: Human Body Systems: Physiology, Disorders and Health Solutions
- Unit 20: Human Body Systems: Regulation, Control and Reproduction.

 © Pearson Education Limited 2026

Unit 2: Principles and Applications of Chemistry

Level: 3

Unit type: Pearson Set Assignment

Guided learning hours: 60

Unit in brief

This unit explores atomic structure, chemical bonding, organic chemistry and quantitative analysis, linking theories to practical applications.

Unit introduction

This unit connects chemistry to real-world contexts by giving students essential knowledge that supports daily life, industry and scientific progress. Through studying atomic structure, bonding, organic chemistry and quantitative analysis, you learn how materials behave, how technologies develop and how chemical processes affect the environment. Such understanding benefits scientific careers and informed citizenship.

The unit covers atoms, electrons, chemical bonding and the properties of substances in depth. You will study the classification and naming of organic compounds, their behaviours and their industrial and environmental importance. Quantitative chemistry, including moles, calculations, empirical formulae and gravimetric analysis, strengthens both theory and practical skills while developing analytical and problem-solving abilities.

Completing this unit provides a strong foundation for further study or employment. The skills gained support progression in chemistry, biology, environmental science and related fields. Students develop valued competencies such as data interpretation, critical thinking and laboratory practice. The unit also highlights chemistry's role in global challenges, encouraging lifelong learning and meaningful professional contribution.

Learning aims

In this unit, you will:

A Understand atomic and electronic structure

B Understand chemical bonding and structure

C Understand the principles of organic chemistry

D Understand the use of the mole concept in quantitative chemistry.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Understand atomic and electronic structure	**A1** Atomic structure **A2** Electronic configuration **A3** Relative atomic mass and isotopic abundance **A4** Ionisation energy	Pearson Set Assignment.
B Understand chemical bonding and structure	**B1** Types of chemical bonding **B2** Representing chemical bonds and structures **B3** Properties of substances **B4** Molecular shapes and bond angles **B5** Electronegativity, polarity and intermolecular forces	
C Understand the principles of organic chemistry	**C1** Organic chemistry **C2** Classification of hydrocarbons **C3** Nomenclature and structural representation **C4** Structure and physical properties **C5** Chemistry of alkanes and alkenes **C6** Commercial importance and environmental impact	
D Understand the use of the mole concept in quantitative chemistry	**D1** The Mole concept **D2** Calculations involving moles **D3** Empirical formulae and stoichiometry **D4** Gravimetric analysis	

Content

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

Learning aim A: Understand atomic and electronic structure [EL – MOL]

A1 Atomic structure

- The atom:
  - atoms consist of a nucleus (protons and neutrons) and electrons in shells
  - atomic number (Z) is the number of protons and defines the element
  - mass number (A) is the total number of protons and neutrons:

$$A = \text{number of protons} + \text{number of neutrons}$$

- Isotopes:
  - atoms of the same element with different numbers of neutrons
  - isotopes have identical chemical properties but different physical properties due to mass differences.

A2 Electronic configuration

- Electron arrangement:
  - electrons occupy energy levels (shells) around the nucleus
  - arrangement follows the Aufbau principle: lower energy levels fill first
  - each shell has a maximum capacity (e.g. 2 in the first shell, 8 in the second).
- Subshells and orbitals:
  - shells contain subshells (s, p, d, f) with specific numbers of orbitals
  - electronic configuration determines chemical reactivity and bonding.

A3 Relative atomic mass and isotopic abundance

- Calculating relative atomic mass:
  - relative atomic mass is a weighted average based on isotopic abundances
  - calculation involves multiplying each isotope's mass by its abundance, summing and dividing by 100.
- Determining isotopic abundance:
  - given the relative atomic mass and isotope masses, percentage abundances can be calculated
  - calculation of the relative atomic mass of an element with two isotopes:

$$A_r = \frac{(\text{mass}_1 \times \text{abundance}_1) + (\text{mass}_2 \times \text{abundance}_2)}{100}$$

A4 Ionisation energy

- Definition and trends:
  - ionisation energy is the energy required to remove an electron from a gaseous atom
  - successive ionisation energies reveal the arrangement of electrons in shells.
- Factors affecting ionisation energy:
  - nuclear charge – more protons increase attraction to electrons
  - electron shielding – inner electrons reduce the effective nuclear charge felt by outer electrons
  - subshell structure – electrons in different subshells experience different levels of attraction.

Learning aim B: Understand chemical bonding and structure

B1 Types of chemical bonding

- Metallic bonding:
  - structure of metallic lattices: positive ions in a sea of delocalised electrons
  - metallic properties: electrical conductivity, malleability, ductility.
- Ionic bonding:
  - formation of ions through electron transfer between metals and non-metals
  - ionic lattice structure and its impact on melting points and solubility
  - electrical conductivity in molten and aqueous states.
- Covalent bonding:
  - electron sharing between non-metal atoms
  - formation of simple molecules and giant covalent structures
  - influence on melting points, solubility and electrical conductivity.

B2 Representing chemical bonds and structures

- Use of dot and cross diagrams to show electron transfer or sharing.
- Lattice diagrams to illustrate the arrangement of ions or atoms in solids.
- Examples of common compounds: sodium chloride (ionic), water (covalent), copper (metallic).

B3 Properties of substances

- Ionic compounds (high melting points, electrical conductivity when molten or dissolved, solubility in water).
- Covalent compounds (low melting points for simple molecules, high for giant covalent structures, poor electrical conductivity).
- Metallic substances (high melting points, good electrical and thermal conductivity, malleability).

B4 Molecular shapes and bond angles

- Introduction to electron pair repulsion theory (VSEPR).
- Predicting shapes (linear, trigonal planar, tetrahedral, bent).
- Typical bond angles associated with each shape:
  - linear 180°
  - triganol planar 120°
  - tetrahedral 109.5°
  - bent 104°.

B5 Electronegativity, polarity and intermolecular forces

- Definition and trends in electronegativity.
- How differences in electronegativity create polar bonds and molecules.
- The role of molecular shape in determining overall polarity.
- Types of intermolecular forces: hydrogen bonding, dipole-dipole, London dispersion.
- Impact of polarity and intermolecular forces on physical properties.

Learning aim C: Understand the principles of organic chemistry

C1 Organic chemistry

- Compounds containing carbon, typically bonded with hydrogen, oxygen, nitrogen and other elements.
- Organic molecules as fundamental to biological processes and industrial applications.
- Key features (covalent bonding, molecular diversity, and the presence of functional groups).

C2 Classification of hydrocarbons

- Saturated hydrocarbons (Alkanes):
  - only single bonds between carbon atoms
  - general formula: C_nH_{2n+2}
  - examples (methane, ethane, propane)
  - properties, e.g. relatively unreactive, used as fuels.
- Unsaturated hydrocarbons (alkenes and alkynes):
  - contain double (alkenes) or triple (alkynes) bonds
  - general formulae: alkenes (C_nH_{2n}), alkynes (C_nH_{2n-2})
  - examples (ethene, propene, ethyne)
  - properties, e.g. more reactive, participate in addition reactions.

C3 Nomenclature and structural representation

- Systematic naming (International Union of Pure and Applied Chemistry (IUPAC) rules) based on:
  - number of carbon atoms
  - type of bonds (single, double, triple)
  - presence and position of functional groups.
- Structural formulae – show the arrangement of atoms.
- Isomerism:
  - structural isomers – same molecular formula, different connectivity
  - stereoisomers – same connectivity, different spatial arrangement.

C4 Structure and physical properties

- Molecular structure influences on boiling point, melting point, solubility and density.
- Isomerism effects on physical properties and chemical reactivity.
- Example: e.g. butane and isobutane (structural isomers) have different boiling points.

C5 Chemistry of alkanes and alkenes

- Alkanes:
  - undergo combustion (energy production) and substitution reactions
  - uses as fuels, lubricants, and as starting materials in chemical synthesis.
- Alkenes:
  - undergo addition reactions (e.g. hydrogenation, halogenation)
  - important in polymer production (e.g. polyethylene)
  - uses in manufacturing chemicals and plastics.

C6 Commercial importance and environmental impact

- Organic compounds are essential in pharmaceuticals, agriculture and manufacturing.
- Environmental concerns:
  - pollution from production and disposal
  - greenhouse gas emissions from combustion
  - human health risks from exposure to certain compounds.
- Solutions:
  - development of greener synthesis methods
  - recycling and use of biodegradable materials
  - regulation and monitoring of industrial processes.

Learning aim D: Understand the use of the mole concept in quantitative chemistry

D1 The Mole concept

- Definition of a mole and Avogadro's number.
- Relationship between moles, mass, molar mass and number of particles:

$$\text{Moles} = \frac{\text{Mass (g)}}{\text{Molar mass (g/mol)}}$$

- Use of the mole in chemical calculations.

D2 Calculations involving moles

- Calculating moles from:
  - mass and molar mass
  - concentration and volume of solutions:

$$\text{Moles} = \text{Concentration (mol / dm}^3\text{)} \times \text{Volume(dm}^3\text{)}$$

  - gas volumes at room temperature and pressure.
- Converting moles to number of particles using Avogadro's constant.
- Worked examples and practice exercises.

D3 Empirical formulae and stoichiometry

- Determining empirical formulae from experimental data.
- Using mole ratios to balance chemical equations.
- Calculating stoichiometric relationships from reacting masses and gas volumes.
- Application in predicting product quantities.

D4 Gravimetric analysis

- Principles of gravimetric analysis.
- Calculating percentage yield:

$$\text{Percentage yield} = \frac{\text{Actual yield}}{\text{Theoretical yield}} \times 100\%$$

- Common procedures and sources of error:
  - loss of product
  - incomplete reactions
  - measurement inaccuracies.
- Accuracy:
  - use of precise equipment
  - ensuring complete precipitation or reaction
  - minimising contamination.

Assessment criteria

Learning aim A: Understand atomic and electronic structure

Pass	Merit	Distinction
A.P1 Describe how elements are defined by their atomic number, mass number and electronic configuration. **A.P2** Determine relative atomic masses of elements from isotopic abundances and vice versa.	**A.M1** Analyse successive ionisation energy data to provide evidence for the electronic configuration of elements. **A.M2** Explain the chemistry of groups 1, 7 and 0 in terms of electron configuration.	**A.D1** Evaluate factors affecting ionisation energy across a period, linking trends to shielding, nuclear charge and subshell structure.

Learning aim B: Understand chemical bonding and structure

Pass	Merit	Distinction
B.P3 Describe metallic, ionic and covalent bonding with appropriate dot and cross diagrams and lattice representations. **B.P4** Explain typical properties of ionic, covalent and metallic substances, including melting points and electrical conductivity.	**B.M3** Predict the shapes and bond angles of molecules using electron pair repulsion theory.	**B.D2** Assess how electronegativity and molecular shape determine the polarity and intermolecular forces of molecules.

Learning aim C: Understand the principles of organic chemistry

Pass	Merit	Distinction
C.P5 Describe the difference in bonding between saturated and unsaturated hydrocarbons. **C.P6** Determine names and structures for a range of organic compounds. **C.P7** Review the chemistry of alkanes and alkenes, including reactions of commercial importance.	**C.M4** Explain the effect of structure and isomerism on the physical properties of organic compounds.	**C.D3** Discuss benefits and environmental problems of organic compounds, suggesting possible solutions.

Learning aim D: Understand the use of the mole concept in quantitative chemistry

Pass	Merit	Distinction
D.P8 Calculate moles and number of particles from masses, concentrations and gas volumes and vice versa.	**D.M5** Determine empirical formulae and stochiometric equations from reacting masses and gas volumes.	**D.D4** Evaluate the accuracy of the procedures used in gravimetric analysis and suggest improvements.

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 a part of wider teaching and learning
√	Embedded in teaching, learning and assessment
blank	Not embedded or signposted in unit

Essential information for Pearson Set Assignment (PSA)

Pearson sets the assignment for the assessment of this unit.

The PSA will take 20 hours to complete.

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

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

Assessing the PSA

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

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

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- Laboratory equipment and chemicals – glassware, balances, heating apparatus, reagents for redox, bonding and organic synthesis experiments.
- Visual and modelling tools – periodic tables, molecular model kits, 3D structure software and diagrams.
- Data and calculation tools – scientific calculators, spreadsheets, and graphing software for mole calculations, kinetics, energetics and equilibrium analysis.

Essential information for assessment decisions

Learning aim A

For distinction standard, student’s evidence reflects a comprehensive and analytical approach to atomic and electronic structure. They critically evaluate the impact of isotopic variation on both chemical and physical properties and articulate the significance of electronic configuration in predicting chemical behaviour and reactivity. Their calculations are precise, and they can interpret complex data sets to deduce isotopic abundances. The student synthesises information about ionisation energy trends, integrating multiple factors and supporting their conclusions with scientific reasoning. Their work demonstrates an ability to apply atomic theory to novel contexts and to explain the implications for chemical processes and material properties.

For merit standard, students interpret atomic and electronic structure with greater depth, providing detailed accounts of how isotopic differences influence physical properties and chemical behaviour. Their evidence includes well-reasoned explanations of electron arrangements, referencing subshells and orbitals, and how these relate to chemical reactivity and bonding. Calculations of relative atomic mass and isotopic abundance are accurate and justified, with the student able to discuss trends in ionisation energy and the underlying causes, such as nuclear charge, electron shielding and subshell structure. The student’s work demonstrates the ability to connect atomic theory to observable chemical phenomena.

For pass standard, students show a secure understanding of atomic structure by clearly describing the composition and function of protons, neutrons and electrons within the atom. Their work demonstrates the ability to distinguish between atomic number and mass number, and to explain the concept of isotopes, including how isotopes of the same element differ in physical properties due to variations in neutron number. The student provides basic electronic configurations and can perform straightforward calculations of relative atomic mass using given data. Evidence includes identification of factors that affect ionisation energy, such as nuclear charge and electron shielding, with examples that reflect a sound grasp of fundamental principles.

Learning aim B

For distinction standard, students present sophisticated evidence, analysing the relationships between bonding, structure and properties in a range of substances. Their diagrams are precise and annotated, and they critically evaluate how molecular geometry and polarity influence chemical behaviour and interactions. The student integrates knowledge of intermolecular forces to explain complex phenomena, such as anomalous boiling points or solubility trends, and supports their interpretations with scientific literature or experimental data. Their work demonstrates an ability to apply theoretical models to explain real-world chemical behaviour and to justify predictions about substance properties based on bonding and structure.

For merit standard, student's work demonstrates a deeper understanding of chemical bonding, with detailed diagrams and explanations of how bonding type influences substance properties. They interpret molecular shapes using electron pair repulsion theory, accurately predicting bond angles and relating these to molecular geometry. The student discusses the effects of electronegativity and polarity on physical properties, providing reasoned accounts of intermolecular forces and their impact on melting points, solubility and conductivity. Their evidence shows the ability to compare and contrast different bonding types and to explain how these differences manifest in observable properties.

For pass standard, students provide clear descriptions of different types of chemical bonding, supported by basic diagrams and examples that illustrate the structures of ionic, covalent and metallic substances. Their evidence includes the identification of key properties, such as melting points, electrical conductivity and solubility, as well as simple representations of molecular shapes and bond angles. The student can outline how electronegativity and polarity affect molecular behaviour, referencing common intermolecular forces such as hydrogen bonding and London dispersion forces. Their work demonstrates a foundational understanding of how bonding and structure influence the physical and chemical properties of substances.

Learning aim C

For distinction standard, students demonstrate advanced insight into organic chemistry, critically analysing molecular structure and its influence on reactivity and properties. Their evidence includes complex examples of isomerism and its practical implications for chemical synthesis and product formulation. The student evaluates the commercial importance and environmental challenges of organic compounds, proposing innovative solutions and referencing scientific research or industry developments. Their work shows an ability to synthesise information from multiple sources and apply organic chemistry principles to address real-world problems in pharmaceuticals, agriculture and environmental management.

For merit standard, student's evidence shows a thorough understanding of organic chemistry principles, with accurate classification and systematic naming of a range of hydrocarbons and functional groups. They interpret structural and stereoisomerism, explaining effects on physical properties and chemical reactivity. The student discusses reaction types for alkanes and alkenes, providing examples of combustion, substitution and addition reactions. They evaluate the environmental impact of organic compounds, referencing current practices and solutions such as green synthesis and recycling. Their work demonstrates the ability to connect organic chemistry concepts to industrial and environmental contexts.

For pass standard, students identify key features of organic compounds, classify hydrocarbons as saturated or unsaturated, and apply basic nomenclature rules to name simple organic molecules. Their evidence includes straightforward structural representations and recognition of isomerism, with examples that demonstrate an understanding of how molecular structure affects physical properties such as boiling point and solubility. The student describes the commercial and environmental significance of organic compounds, outlining their uses in industry and the impact of their production and disposal on the environment. Their work shows a foundational grasp of organic chemistry concepts and their relevance to everyday life.

Learning aim D

For distinction standard, students present comprehensive evidence, integrating complex quantitative calculations and critically analysing experimental results. They synthesise data to predict product quantities and evaluate the limitations of gravimetric analysis, discussing sources of error and strategies for improvement. The student proposes enhancements to experimental design, demonstrating an advanced understanding of accuracy, precision and the significance of quantitative methods in chemistry. Their work shows an ability to apply the mole concept to novel contexts, interpret complex datasets, and justify conclusions with scientific reasoning and evidence.

For merit standard, student's work demonstrates proficiency in quantitative chemistry, with precise calculations involving moles, concentrations and gas volumes. They interpret experimental data to determine empirical formulae and balance chemical equations, showing an ability to use mole ratios to predict product quantities. The student evaluates gravimetric analysis procedures, discussing accuracy and reliability, and suggests methods to minimise errors, such as using precise equipment and ensuring complete reactions. Their evidence shows the ability to apply quantitative concepts to a range of chemical scenarios and critically assess the reliability of experimental results.

For pass standard, students provide accurate definitions and calculations involving the mole concept, including conversions between mass, moles and the number of particles using Avogadro's number. Their evidence includes basic chemical calculations and determination of empirical formulae from simple data sets, demonstrating an ability to apply quantitative methods to solve straightforward problems. The student outlines the principles of gravimetric analysis and identifies common sources of error, such as loss of product or incomplete reactions. Their work shows a foundational understanding of the role of the mole in chemical calculations and the importance of accuracy in quantitative analysis.

Links to other units

This unit gives underpinning knowledge, understanding and skills linked to:

- Unit 7: Chemical Principles and Reaction Systems
- Unit 15: Applications of Physical, Inorganic and Organic Chemistry
- Unit 19: Atmospheric Science and Climate Change.

Unit 3: Principles and Applications of Physics

Level: 3

Unit type: Pearson Set Assignment

Guided learning hours: 60

Unit in brief

The unit explores wave properties, optical fibres and electromagnetic communication – forces in transportation and electrical energy transfer. Students study theoretical principles and apply them through practical investigations, calculations and real-world scenarios.

Unit introduction

This unit links directly to science, engineering and modern technology, where understanding waves, forces and electrical systems supports many real-world applications. From fibre-optic communication to vehicle safety and energy efficiency, these principles shape everyday experiences. Students learn how scientific ideas become practical solutions, building confidence in analysing technologies and solving problems in academic and professional contexts.

The unit covers a wide range of interconnected topics, including wave behaviour, fibre-optic principles and electromagnetic communication. You will study motion, forces and Newton's laws in transport, as well as electrical circuits, energy transfer and thermal processes. Through equations and practical investigations, you develop strong theoretical understanding, accurate calculation skills and the ability to relate concepts to real systems.

Completing this unit provides a solid route into higher study in physics, engineering and technology fields, and supports careers in telecommunications, transport and energy. Students strengthen analytical and problem-solving abilities valued by employers. By applying scientific principles to realistic scenarios, you enhance your employability and prepare effectively for fast-moving, technology-focused industries.

Learning aims

In this unit, you will:

A Understand features and uses of waves and optical fibres

B Explore forces in transportation

C Examine electrical circuits and the transfer of energy.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Understand features and uses of waves and optical fibres	**A1** Working with waves **A2** Principles of optical fibres **A3** Uses of electromagnetic waves in communication	Pearson Set Assignment.
B Explore forces in transportation	**B1** Measurement and representation of motion **B2** Laws of motion	
C Examine electrical circuits and the transfer of energy	**C1** Use of electrical components **C2** Equations **C3** Electrical energy usage **C4** Energy transfer **C5** Change of state	

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

Content

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

Learning aim A: Understand features and uses of waves and optical fibres
[EL – MOL]

A1 Working with waves

- Features common to waves
  - understand terminology:
    - periodic time
    - wave speed
    - wavelength
    - frequency
    - amplitude
    - oscillation
  - graphical and diagrammatic representation of wave features.
- Similarities and differences between transverse and longitudinal waves.
- Concepts of displacement, coherence, path difference, phase difference and superposition of waves as applied to diffraction gratings:
  - emission of different light frequencies due to electron energy level changes within the atom
  - using diffraction gratings to form line emission spectra
  - using the lines of emission spectra to identify elements in gases.
- Using the wave equation: $v = f\lambda$
- Concepts and applications of stationary waves and resonance in strings and pipes:
  - concepts and applications of stationary waves and resonance to musical instruments
  - 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

- Concept of refraction and total internal reflection (TIR):
  - use equations for refractive index

$$n = \frac{C}{V} = \frac{Sin\ i}{Sin\ r}$$

  - know that TIR only occurs when the angle of incidence in the more optically dense medium is greater than the critical angle

- calculate the critical angle at a glass-air interface given the refractive index of glass using:

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

- know how cladding of optical fibres affects the critical angle in the fibre.

- Applications of optical fibres in engineering, communication and medicine.
- Differences between analogue and digital signals.

A3 Uses of electromagnetic waves in communication

- All electromagnetic waves travel at the speed of light in a vacuum.
- Use the inverse square law in relation to the intensity of a wave:

$$I = \frac{k}{r^2}$$

- Regions of electromagnetic spectrum overlap and have different frequencies and wavelengths:
  - using electromagnetic waves and frequencies in communication applications, to include:
    - satellite-based communication and navigation systems
    - cell/mobile phones
    - Bluetooth©
    - infrared
    - Wi-Fi

Learning aim B: Explore forces in transportation

B1 Measurement and representation of motion

- Standard SI units:
  - standard SI units and symbols for initial velocity (u), final velocity (v), distance and displacement (s), time (t) and acceleration (a)
  - units of speed: kilometres per second (kms^{-1}), kilometres per hour (kmh^{-1}).
- Calculating speed and average speed:
  - speed = distance ÷ time
  - average speed = total distance ÷ total time.
- Using vector and scalar quantities to describe motion:
  - using velocity as a vector quantity that has magnitude and direction
  - using distance as a scalar quantity that has magnitude only
  - using displacement-time graphs to find velocity
  - using velocity-time graphs to describe the motion of an object

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

  - using velocity-time graphs to find the distance travelled from the area beneath the graph
  - using velocity-time graphs to find acceleration as rate of change of velocity from the gradient of the graph

$$a = \frac{(v - u)}{t}$$

  - find the acceleration of a trolley moving down a gradient
  - use equations for the calculation of motion:

$$s = \frac{(u + v)t}{2}$$
$$v = u + at$$
$$s = ut + \frac{1}{2}at^2$$
$$v^2 = u^2 + 2as$$

- Understand the applications of accelerometers, to include: wearable activity trackers, cell/mobile phones and blood pressure monitors.

B2 Laws of motion

- Newton's first law of motion – the application of a resultant force to make an object move or stop.
- Definitions of inertia, mass and weight:
  - inertia as a resistance to change in motion
  - gravitational field strength (g) and weight
  - calculations for weight, equation $W = mg$.
- 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:
  - measuring coefficient of static friction, where F is the force applied just as the object is about to move
  - measuring coefficient of dynamic (kinetic) friction, where F is the force applied to keep the object moving at a constant velocity.
- Calculating the momentum (p) of objects using the equation $p = mv$.
- Using Newton's second law of motion, force is proportional to rate of change of momentum, to include:

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

  - force is proportional to acceleration for a constant mass
  - calculations using Newton's second law
  - implications for transportation when travelling at high speed with low mass and low speed with high mass

- use of impact force controls:
  - air bags
  - seat belts
  - helmets for motorcycle users
  - passenger 'cells'
  - crumple zones
- Newton's third law of motion action and reaction are equal and opposite.
- Know that if *F* is the resultant force on an object, the object accelerates and if the forces are balanced, *F* is zero and the object is moving at a constant velocity or stationary:
  - effect of air resistance, drag and terminal velocity in different applications, to include:
    - vehicles on roads
    - falling parachutes
    - objects falling in liquids

Learning aim C: Examine electrical circuits and the transfer of energy

C1 Use of electrical components

- Identifying circuit symbols.
- Defining terminology – current, potential difference, energy and power:
  - 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)
- Connecting circuits with cells, batteries, power supplies, lamps, resistors, variable resistors, switches, ammeters and voltmeters:
  - using electrical meters in series and parallel to measure current and potential difference
  - using an ohmmeter to measure the resistance of a component.
- Using electrical components in circuits:
  - filament lamps
  - diodes
  - thermistors
  - light-dependent resistors (LDR)
  - photodiodes and light-emitting diodes (LEDs).

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

C2 Equations

- Using equations for electrical calculations:
  - power = potential difference × current ($P = IV$)
  - voltage = current × resistance ($V = IR$)
  - power = work done/time

    $(P = \frac{E}{t})$
  - energy = potential difference × current × time ($E = VIt$)
  - efficiency:

$$\text{Efficiency (\%)} = \frac{\text{Useful Output Energy or Power}}{\text{Total Input Energy or Power}} \times 100$$

C3 Electrical energy usage

- Relating to different domestic appliances to calculate energy usage.
- Relating fuse size to current.
- Calculating transferred energy using the equation:

  Energy transferred = power in kilowatts × time in hours (kWh = kW × h)

C4 Energy transfer

- Defining units – joules (J), kilojoules (kJ), mega joules (MJ).
- Converting temperatures between Celsius (°C) and kelvin (K).
- The transfer of energy to give a change of temperature and a change of state.
- Temperature change:
  - measuring specific heat capacity of liquids and solids
  - using equation:

  Thermal energy = mass × specific heat capacity × temperature change
  $\Delta Q = m c \Delta T$
  - unit of measurement of specific heat capacity $J\ kg^{-1}K^{-1}$

C5 Change of state

- Measuring specific latent heat fusion and vapourisation for a liquid.
- Using the equation:

  Thermal energy = mass x specific latent heat. $\Delta Q = m L$

Assessment criteria

Learning aim A: Understand features and uses of waves and optical fibres

Pass	Merit	Distinction
A.P1 Describe wave terminology and relationships using graphs, including frequency, wavelength, amplitude, speed and oscillation. **A.P2** Explain optical fibre TIR and critical angle calculations, and inverse-square intensity for real-world contexts.	**A.M1** Analyse superposition, coherence, path difference and phase difference as applied to diffraction grating.	**A.D1** Discuss the importance of atomic energy levels in the production of line emission spectra used for identifying elements and scientific advancements.

Learning aim B: Explore forces in transportation

Pass	Merit	Distinction
B.P3 Use SI units and motion representation using displacement-time and velocity-time graphs with accurate calculations of speed. **B.P4** Use equations of motion and graphs to determine distances travelled, velocity and acceleration.	**B.M2** Analyse Newton's laws, momentum, weight, friction coefficients and resultant forces for transportation safety implications and control effectiveness.	**B.D2** Evaluate air resistance, drag and terminal velocity across applications, with coherent design trade-offs for different vehicle contexts.

Learning aim C: Examine electrical circuits and the transfer of energy

Pass	Merit	Distinction
C.P5 Describe circuit symbols, measurement units and safe connections using meters to measure current, potential difference and resistance. **C.P6** Explain methods of measuring specific heat capacity and latent heat in practical investigations of materials.	**C.M3** Discuss applications of electrical equations in calculating power, resistance and energy transfer across domestic appliances.	**C.D3** Evaluate efficiency and limitations of energy transfer methods in electrical systems and domestic appliances.

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 a part of wider teaching and learning
√	Embedded in teaching, learning and assessment
blank	Not embedded or signposted in unit

 © Pearson Education Limited 2026

Essential information for Pearson Set Assignment (PSA)

Pearson sets the assignment for the assessment of this unit.

The PSA will take 20 hours to complete.

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

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

Assessing the PSA

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

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

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- Wave and optics kits – includes ripple tanks, diffraction gratings, optical fibres and laser pointers for demonstrating wave behaviour and TIR.
- Motion and force apparatus – trolleys, ramps, accelerometers, force sensors and friction blocks for practical exploration of Newton's laws and motion.
- Electrical circuit boards – breadboards, power supplies, resistors, meters and components like LEDs, thermistors and LDRs for circuit construction and testing.
- Data-logging and simulation software – tools for graphing motion, analysing wave patterns and modelling energy transfer for accurate interpretation and evaluation.

Essential information for assessment decisions

Learning aim A

For distinction standard, students provide a comprehensive evaluation of wave phenomena and optical fibre applications, demonstrating depth, clarity and critical insight. Evidence should include accurate applications of stationary wave and resonance principles, supported by calculations using $v = \sqrt{(T/\mu)}$. Students critically assess the role of diffraction gratings in producing line emission spectra and explain how these spectra are used to identify elements based on electron energy level transitions. They should evaluate the effectiveness and limitations of diffraction grating methods for spectral analysis, considering factors such as resolution, coherence and practical implementation in engineering or scientific contexts. Responses integrate multiple concepts, including wave behaviour, optical fibre performance and electromagnetic communication, and justify their relevance to real-world systems such as telecommunications and medical imaging. Work demonstrates independent thinking, realistic assessment of design implications, and confident use of technical language and calculations.

For merit standard, students demonstrate coherent analysis of wave behaviour, optical fibre principles and electromagnetic communication. Evidence includes accurate calculations, logical reasoning and effective interpretation of diffraction, emission spectra and signal transmission. Students apply concepts to practical scenarios, such as medical imaging or data transfer, showing consistent accuracy and confidence. Work reflects a deeper understanding of interrelated principles and their implications for applied contexts, such as engineering and communication technologies.

For pass standard, students show understanding of wave properties and optical fibre principles through descriptions and accurate terminology. Evidence includes correct use of basic equations, simple diagrams and sometimes simple explanations of refraction, TIR and electromagnetic wave applications. Work demonstrates a comprehension of essential concepts without significant errors, although depth and application to at least two different real-world contexts, such as satellite, mobile, infrared or Wi-Fi communications, are lacking.

Learning aim B

For distinction standard, students produce in-depth evaluations of forces in transportation, critically assessing the impact of air resistance, drag and terminal velocity linked to different vehicle motion contexts, including road vehicles, aircraft, spacecraft and ships. Evidence includes realistic assessments of design changes for vehicles, parachutes and safety systems, supported by accurate calculations and coherent arguments. Students justify recommendations and integrate multiple concepts, demonstrating theoretical and practical aspects with critical insight.

For merit standard, students provide detailed analysis of motion and force principles, applying Newton's laws and friction concepts to transportation scenarios. Evidence includes accurate calculations, interpretation of graphs, and logical reasoning about safety features such as crumple zones and airbags. Students demonstrate consistent accuracy and confidence in linking theoretical principles to practical implications, showing a deep understanding of how forces influence vehicle performance and passenger safety.

For pass standard, students demonstrate understanding of motion, forces and Newton's laws through descriptions and correct use of SI units. Evidence includes simple calculations for speed, acceleration and momentum, supported by largely clear diagrams and graphs. Work shows a comprehension of friction, inertia and weight, although its application to transportation safety may lack depth.

Learning aim C

For distinction standard, students produce a comprehensive evaluation of electrical systems and energy transfer, demonstrating depth, clarity and critical insight. Evidence should include accurate application of electrical equations, such as $V = IR$, $P = IV$ and $E = VIt$, as well as calculations for energy usage in kWh. Students must explicitly calculate and interpret efficiency. They should apply this to real-world scenarios, such as comparing energy losses in circuits, assessing thermal energy transfer, and evaluating the performance of domestic appliances or transport systems. Responses should justify design decisions based on efficiency outcomes, safety considerations and cost implications. Students integrate multiple concepts, including specific heat capacity and latent heat, to assess energy management strategies, demonstrating mastery and independent thinking with realistic, evidence-based recommendations.

For merit standard, students provide coherent analysis of electrical principles, applying equations for voltage, current, resistance and power to practical scenarios. Evidence includes accurate calculations, logical reasoning, and reasonable interpretation of component behaviour in circuits. Students demonstrate consistent accuracy when linking energy transfer to efficiency and safety, showing understanding of how electrical systems operate in typical domestic contexts.

For pass standard, students demonstrate key understanding of electrical circuits and energy transfer through clear descriptions and accurate use of terminology. Evidence should include correct identification of circuit symbols, safe construction of series and parallel circuits, and basic calculations using standard equations such as $V = IR$ and $P = IV$. Students also show comprehension of thermal energy concepts by explaining and applying the equations for specific heat capacity and latent heat in simple contexts. Work may include straightforward examples of energy transfer during heating or state changes, with correct units and logical structure. While responses meet essential requirements for clarity and accuracy, they may lack depth or detailed evaluation of efficiency or real-world implications.

Links to other units

This unit gives underpinning knowledge, understanding and skills linked to

- Unit 8: Physics for Energy, Materials, and Communication
- Unit 18: Modern Materials and Sustainable Technologies
- Unit 22: Pollution and Waste Management.

Unit 4: Real-World Scientific Mathematics

Level: 3

Unit type: Pearson Set Assignment

Guided learning hours: 60

Unit in brief

Sequences, series, matrices, complex numbers and statistical methods are applied to solve real-world problems in science. Students progress from routine calculations to advanced problem solving and evaluation using accurate mathematical reasoning.

Unit introduction

This unit supports real-world problem solving by giving students mathematical tools essential in science, engineering and technology. Knowledge of sequences, series, matrices, complex numbers and statistics helps model and interpret practical situations, from forecasting patterns to analysing systems. These skills enable informed decision-making and form the basis of many modern processes and innovations.

The unit introduces a wide range of mathematical concepts that build in depth and complexity. You will study arithmetic and geometric sequences, power series, matrix methods and determinants for linear systems. Complex numbers support more advanced applications, while statistics, probability distributions and regression techniques develop your ability to analyse data and tackle non-routine problems critically and accurately.

Completing this unit strengthens analytical thinking and problem-solving abilities valued in higher education and technical careers. Applying mathematical reasoning to real-world challenges supports progression into STEM pathways, including engineering, data analysis and applied sciences. The unit provides a strong mathematical foundation that promotes lifelong learning, professional development and success in modern technical industries.

Learning aims

In this unit, you will:

A Examine how sequences and series can be used to solve real-world problems

B Examine how matrices and determinants can be used to solve real-world problems

C Examine how complex numbers can be used to solve real-world problems

D Investigate how statistical and probability techniques can be used to solve real-world problems.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Examine how sequences and series can be used to solve real-world problems	**A1** Arithmetic and geometric progressions **A2** Binomial expansion **A3** Power series	Pearson Set Assignment.
B Examine how matrices and determinants can be used to solve real-world problems	**B1** Matrices **B2** Determinants	
C Examine how complex numbers can be used to solve real-world problems	**C1** Complex numbers	
D Investigate how statistical and probability techniques can be used to solve real-world problems	**D1** Statistical techniques **D2** Probability distributions **D3** Statistical investigation	

Content

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

Learning aim A: Examine how sequences and series can be used to solve real-world problems

A1 Arithmetic and geometric progressions

- Definitions:
  - sequence as an ordered collection of numbers *a*, *b*, *c*, *d*
  - progression as a sequence that increases in a particular pattern, i.e. there is a constant relationship between a number and its successor
  - series as the sum of the values in a sequence *a* + *b* + *c* + *d* …
  - terminology – first term *a*, last term *l*, connection by law.
- Routine operations involve:
  - Arithmetic progression (AP):
    - common difference *d*
    - general expression for a sequence in AP: *a*, (*a* + *d*), (*a* + 2*d*), (*a* + 3*d*), … a+(*n*-1)*d*
    - *n*th term (last term) *l* = *a* + (*n* – l)*d*
    - sum of an AP to *n*th term (arithmetic series):

$$s = a + (a + d) + (a + 2d) + \cdots + (l - d) + l = \frac{1}{2}\, n\, (a + l)$$

  - Geometric progression (GP):
    - common ratio *r*
    - general expression for a sequence in GP $a, ar, ar^2, ar^3, \ldots, ar^{(n-1)}$
    - sum of a GP to *n*th term (geometric series):

$$s = a + ar + ar^2 + ar^3 + \cdots + ar^n = \frac{a\,(1 - r^n)}{(1 - r)}$$

  - convergence
  - sum to infinity.
- Non-routine operations involve:
  - real-world applications, e.g. machinery speeds, increasing or decreasing pattern requirements, drilling costs, manufacturing estimation.

A2 Binomial expansion

- Definitions:
  - Binomial expression that takes the form $(a + b)^n$
  - Binomial theorem when n is a positive integer:

    $(a+b)^n = a^n + na^{n-1}b + \frac{n(n-1)}{2!}a^{n-2}b^2 + \frac{n(n-1)(n-2)}{3!}a^{n-3}b^3 + \cdots + b^n$ (a finite series)

  Which can be written as

  $$(a+b)^n = \sum_{k=0}^{k=n} {}_nC_k\, a^{n-k}b^k \text{ where } {}_nC_k = \frac{n!}{(n-k)!k!}$$

  Alternative form

  $$(1+x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \frac{n(n-1)(n-2)}{3!}x^3 + \cdots + x^n$$

  - Binomial theorem when n is not a positive integer:

    $(+x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \frac{n(n-1)(n-2)}{3!}x^3 + \cdots + x^n$ for $-1 < x < 1$ only (an infinite series)
- Routine operations involve:
  - construction of Pascal's triangle
  - expansion of $(a + b)^n$ for positive values of n using Pascal's triangle.
- Non-routine operations involve:
  - expansion of $(1 + x)^n$ for non-positive integer values of n using binomial theorem
  - calculation of the nth term using binomial theorem
  - real-world applications, e.g. small errors, small changes, percentage changes, approximation of errors.

A3 Power series

- Definitions:
  - a power series as

    $$f(x) = a_0 + a_1x + a_2x^2 + a_3x^3 + \cdots + a_nx^n$$
  - a Taylor series as

    $$f(x) = f(a) + f'(a)(x-a) + \frac{f^2(a)}{2!}(x-a)^2 + \cdots + \frac{f^n(a)}{n!}(x-a)^n$$
- Routine operations involve:
  - a Maclaurin series as a Taylor series with $a = 0$
  - convergence and divergence
  - conditions for convergence and divergence.
- Non-routine operations involve:
  - numerical value for e using a power series
  - proof that

    $\frac{\mathrm{d}y}{\mathrm{d}x}(e^x) = e^x$ using series

- real-world applications, e.g. error in area or volume for small error in measurement of length, oscillator frequency for an electrical circuit if components have small errors in their values.

Learning aim B: Examine how matrices and determinants can be used to solve real-world problems

B1 Matrices

- Definitions:
  - matrix type – element and order (row x column)
  - matrix terminology – element, row, column, order (row x column), equality, zero (null matrix), identity (unit) matrix, transpose, square, leading diagonal, triangular.
- Routine operations involve:
  - addition, subtraction, multiplication by a real number
  - inverse of a (2 x 2) matrix
  - solution of sets of simultaneous equations with two variables using inverse matrix methods.
- Non-routine operations involve:
  - multiplication of matrices
  - solution of sets of simultaneous equations with two variables using Gaussian elimination.

B2 Determinants

- Definitions:
  - the determinant of a matrix as a useful value that can be computed from the elements of a square matrix, denoted by det(*A*) or $|A|$
  - a singular matrix is one with the determinant $|A| = 0$.
- Routine operations involve:
  - the determinant of a (2 x 2) matrix
    $A = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$ using $|A| = ad - bc$
  - the inverse of a two-dimensional matrix
    $A = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$ using $A^{-1} = \begin{pmatrix} d & -b \\ -c & a \end{pmatrix}$
- Non-routine operations involve:
  - the determinant of a (3 x 3) matrix
    $A = \begin{pmatrix} a & b & c \\ d & e & f \\ g & h & i \end{pmatrix}$ using

$$|A| = a\begin{pmatrix} e & f \\ h & i \end{pmatrix} - b\begin{pmatrix} d & f \\ g & i \end{pmatrix} + c\begin{pmatrix} d & e \\ g & h \end{pmatrix}$$

- use of Cramer's rule to solve for sets of simultaneous equations with two variables
- real-world applications, e.g. simultaneous linear equations with more than two variables (electrical circuits, vector arrays, machine cutter paths).

Learning aim C: Examine how complex numbers can be used to solve real-world problems

C1 Complex numbers

- Definitions:
  - algebraic form (Cartesian, rectangular notation): $(a + ib)$
  - real part, imaginary part, *i* notation, *i*-operator, powers of *i*
  - modulus:

$$|a + ib| = \sqrt{a^2 + b^2}$$

  - argument:

$$\arg(a + ib) = tan^{-1}\left(\frac{b}{a}\right)$$

  - polar form $r\angle\theta$; θ is usually expressed in radians but may be in another angular measure
  - complex conjugate of $y = a \pm ib$ as $y^* = a \mp ib$.
- Routine operations involve:
  - placement of complex numbers on an Argand diagram
  - addition and subtraction in rectangular form
  - multiplication by a constant coefficient
  - conversion between rectangular and polar forms $r \to p$ and $p \to r$ using trigonometry and a scientific calculator
  - multiplication and division of complex numbers in polar form.
- Non-routine operations involve:
  - multiplication in rectangular form
  - division in rectangular form using the complex conjugate
  - de Moivre's theorem: $(r\angle\theta)^n = r^n\angle n\theta$
  - real-world applications, e.g. vectors, electrical circuit phasor diagrams, algebraic form (Cartesian, rectangular notation): $(a + ib)$
  - real part, imaginary part, *i* notation, *i*-operator, powers of *i*
  - modulus: $|a + ib| = \sqrt{a^2 + b^2}$
  - argument:

$$\arg(a + ib) = tan^{-1}\left(\frac{b}{a}\right)$$

  - polar form $r\angle\theta$; is usually expressed in radians, but may be in another angular measure

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

- complex conjugate of

$$y = a \pm ib \text{ as } y^* = a \mp ib$$

Learning aim D: Investigate how statistical and probability techniques can be used to solve real-world problems

D1 Statistical techniques

- Routine operations involve:
  - discrete data, continuous data, ungrouped data, grouped data, rogue values
  - presentation of data – bar charts, pie charts, histograms, cumulative frequency curves
  - measures of central tendency (location) – arithmetic mean, median, mode
  - measures of dispersion – variance, standard deviation, range and interquartile ranges
  - linear relationship between independent and dependent variables, scatter diagrams, approximate equation of line of regression, y = mx + c, represented graphically.
- Non-routine operations involve:
  - equation of linear regression line *y* = *mx* + where

$$m = \frac{N\sum_1^N (x_i y_i) - \sum_1^N (x_i) \sum_1^N (y_i)}{N\sum_1^N x_i^2 - \left(\sum_1^N x_i\right)^2} \text{ and } c = \overline{y} - m\overline{x}$$

$$\overline{x} = \frac{\sum_1^N x_i}{N} \text{ and } \overline{y} = \frac{\sum_1^N y_i}{N}$$

  - correlation coefficient using Pearson's correlation

$$r_{x,y} = \frac{N\sum_1^N x_i y_i - \sum_1^N x_i \sum_1^N y_i}{\sqrt{N\sum_1^N x_i^2 - \left(\sum_1^N x_i\right)^2} - \sqrt{N\sum_1^N y_i^2 - \left(\sum_1^N y_i\right)^2}}$$

- Use of spreadsheets and/or scientific calculators to calculate the equation of the line of regression and the correlation coefficient, e.g. tabulating calculations using trendline and CORREL function in a spreadsheet or a standard scientific calculator.
- Use of spreadsheets and/or scientific calculators to identify the most appropriate type of regression line, e.g. linear, logarithmic, exponential or variable power.

D2 Probability distributions

- Routine operations involve:
  - normal distribution – shape and symmetry, skew, tables of cumulative distribution function, mean, variance
  - normal distribution curve – areas under it relating to integer values of standard deviation.

D3 Statistical investigation

- The use of appropriate mathematical methods to solve the given real-world problem.
- Real-world applications, e.g. inspection and quality assurance, calculation of central tendencies and dispersion, forecasting, reliability estimates for components and systems, customer behaviour, condition monitoring and product performance.
- Reflection on the problem-solving process and solution(s) obtained; refinements where appropriate.
- Presentation of solution(s) to the given real-world problem.

Assessment criteria

Learning aim A: Examine how sequences and series can be used to solve real-world problems

Pass	Merit	Distinction
A.P1 Solve given problems using routine arithmetic and geometric progression operations. **A.P2** Solve given problems using routine power series operations.	**A.M1** Solve given problems accurately using routine and non-routine arithmetic and geometric progression operations. **A.M2** Solve given problems accurately using routine and non-routine power series operations.	**A.D1** Evaluate, using technically correct language and a logical structure, science problems using non-routine sequence and series operations, while solving all the given problems accurately using routine and non-routine operations.

Learning aim B: Examine how matrices and determinants can be used to solve real-world problems

Learning aim C: Examine how complex numbers can be used to solve real-world problems

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td>B.P3 Solve given problems using routine matrices and determinant operations.</td><td>B.M3 Solve given problems accurately using routine and non-routine matrices and determinant operations.
B.M4 Solve given problems accurately using routine and non-routine complex number operations.</td><td rowspan="2">BC.D2 Evaluate, using technically correct language and a logical structure, science problems using non-routine matrices, determinant and complex operations, while solving all the given problems accurately using routine and non-routine operations.</td></tr>
<tr><td>C.P4 Solve given problems using routine complex number operations.</td><td></td></tr>
</table>

Learning aim D: Investigate how statistical and probability techniques can be used to solve real-world problems

Pass	Merit	Distinction
D.P5 Solve a science problem using routine central tendency, dispersion and probability distribution operations. [SP - PS] **D.P6** Solve a science problem using routine linear regression operations.	**D.M5** Solve a science problem accurately using routine and non-routine central tendency, dispersion and probability distribution operations, providing an explanation of the process. **D.M6** Solve science problems accurately using routine and non-routine regression operations, providing an explanation of the process.	**D.D3** Evaluate the correct synthesis and application of statistics and probability to solve science problems involving accurate routine and non-routine operations.

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 a part of wider teaching and learning
√	Embedded in teaching, learning and assessment
blank	Not embedded or signposted in unit

Essential information for Pearson Set Assignment (PSA)

Pearson sets the assignment for the assessment of this unit.

The PSA will take 3 hours to complete.

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

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

Assessing the PSA

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

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

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- Scientific calculator and mathematical software – tools like Excel, MATLAB or GeoGebra for computations, graphing and matrix operations.
- Visual aids and interactive models –charts, diagrams and digital simulations to illustrate sequences, series, matrices and statistical concepts.
- Data sets and real-world problem scenarios – authentic examples for applying statistical analysis, regression and probability.

Essential information for assessment decisions

Learning aim A

For distinction standard, students evaluate problems involving sequences and series, using technically correct language and a coherent structure. Students will use mathematical methods and terminology precisely and apply relevant units when working with mathematical expressions that model science situations. Small and large numerical values will be correctly presented in an appropriate format, e.g. scientific notation or standard form. Evidence should include the accurate application of non-routine methods and clear justification of the chosen strategies. Carry-through errors (initial incorrect values or mistakes in a multi-step calculation where subsequent steps are performed correctly) are acceptable if they do not detract from the depth of evaluation and the logical consistency of the reasoning presented.

For merit standard, students accurately apply both routine and non-routine techniques for arithmetic, geometric and power series problems. The numerical work will be carried out to an appropriate degree of accuracy, e.g. using appropriate significant figures and decimal places. Solutions show precision most of the time and adaptability to varied contexts. Carry-through errors are acceptable if they do not undermine the demonstration of method selection and logical progression in problem solving.

For pass standard, students demonstrate the ability to apply standard methods for arithmetic, geometric and power series to solve given problems. Evidence should show correct use of equations and logical steps in routine contexts. Minor arithmetic and/or scaling errors are acceptable, as are carry-through errors. Students demonstrate an appreciation of the need to use units correctly, but may make errors in their application. There will also be evidence of simple checks to determine if numerical answers are appropriate.

Learning aims B and C

For distinction standard, students evaluate complex problems involving matrices, determinants and related operations, presenting solutions with technical accuracy and structured reasoning. Evidence should include critical analysis of methods and accurate application of advanced techniques. Students demonstrate the ability to apply routine operations with complex numbers to solve given problems. Evidence should show the correct use of standard techniques and logical progression. Carry-through errors are acceptable if they do not compromise the quality of the evaluation or the logical flow of the solution.

For merit standard, students accurately solve problems using both routine and non-routine matrix and determinant operations. Work should demonstrate precision, adaptability and a clear justification of the chosen methods. Students accurately apply both routine and non-routine methods to solve problems involving complex numbers. Solutions should reflect precision, adaptability and clear explanation of processes. Carry-through errors are acceptable if they do not obscure the student's ability to apply appropriate techniques effectively.

For pass standard, show competence in performing routine operations with matrices and determinants to solve given problems. Evidence should reflect the correct application of standard techniques and logical sequencing of steps. Carry-through errors are acceptable provided the initial method and reasoning are sound. Students demonstrate the ability to apply routine operations with complex numbers to solve given problems. Evidence should show the correct use of standard techniques and logical progression. Students will include evidence of simple checks to determine if numerical answers are appropriate.

Learning aim D

For distinction standard, students evaluate the synthesis and application of statistical and probability methods in solving science problems, using technically correct language and logical structure. The identified problems must be sufficiently complex to allow students to apply both routine and non-routine operations (skills and methods) to their solution. For example, when working with measures of central tendency and dispersion, students may evaluate one set of measured data and four sets of equivalent historical data, such as dimensional data from a machining operation or reliability data from products in service. Before processing any data, students will establish that the datasets are large enough to enable reliable analysis. For regression, students will propose a theoretical relationship between two variables, collect data, and calculate a mathematical relationship between dependent and independent variables using appropriate analytical and graphical methods. They will then reflect on the accuracy of the initial proposal for a linear and a non-linear relationship. Evidence should demonstrate the accurate application of advanced techniques and provide a clear justification for the chosen strategies. Carry-through errors are acceptable if they do not detract from the quality of the evaluation.

For merit standard, students accurately apply both routine and non-routine statistical and regression methods to solve problems, providing clear explanations of processes. Evidence should reflect precision, adaptability and structured reasoning. They will apply appropriate routine and non-routine operations (skills and methods) required to process statistical data accurately. For example, they will tabulate data, produce clear graphical presentations, and calculate mean and standard deviation values to compare measured results with historical data. They will also produce an accurately annotated scatter diagram, including chart and axis titles, units and gridlines, and calculate both the line of regression and correlation coefficient for a linear relationship, as well as a regression line for a non-linear relationship. Carry-through errors are acceptable if they do not obscure the student's ability to apply appropriate techniques effectively.

For pass standard, solutions may not be complete and there may be some inaccuracies or omissions, but there is evidence of proficiency in the method. Students apply the appropriate routine operations (skills and methods) required to process statistical data. Students tabulate measurements and present data in a scatter diagram and may estimate the line of regression graphically. Overall, evidence will be logically presented while containing carry-through errors, e.g. where the mean of a sampled data set is incorrect, but used correctly to find the standard deviation. Selected methods may not be optimal, but the chosen statistical methods are applied correctly. Minor errors or omissions are acceptable, e.g. the axis titles on a scatter diagram may be missing units. There will be an appreciation of the need to use correct units and evidence of simple checks to determine if numerical answers are appropriate.

Links to other units

This unit gives underpinning knowledge, understanding and skills linked to:

- Unit 9: Practical Scientific Procedures and Techniques
- Unit 12: Electrical Circuits and Opportunities
- Unit 15: Applications of Physical, Inorganic and Organic Chemistry
- Unit 17: Medical Instrumentation Techniques for Diagnosis and Therapy.

Unit 5: Contemporary Science Issues

Level: 3

Unit type: Pearson Set Assignment

Guided learning hours: 60

Unit in brief

This unit explores contemporary scientific issues, organisational influences and effective reporting. Students analyse real-world developments, evaluate evidence, and communicate findings for diverse audiences.

Unit introduction

This unit helps students interpret scientific developments that influence everyday life, including energy, food, healthcare and public policy. By examining current issues through social, economic, ethical and environmental perspectives, they learn to distinguish evidence from opinion, identify bias and judge impacts on people and ecosystems. These skills promote responsible citizenship and informed participation in global discussions.

The content covers climate-change mitigation, carbon-neutral strategies, food security, modern agriculture, genetic modification, animal welfare and land use. You will explore clean-energy options such as wind, solar, nuclear, hydro and battery storage, along with health issues from inequalities to vaccination and regenerative medicine. The unit also examines how governments, NGOs, regulators and businesses influence science and how media reporting should use reliable evidence, clear visuals and consistent referencing.

Assessment develops students from informed explanation to critical evaluation, strengthening research, analysis and communication skills valued in education and employment. Learners assess validity, triangulate sources and produce concise third-person reports for general and professional audiences. These outcomes support pathways in applied science, healthcare, environmental management and science communication, preparing students for advanced study and technical or policy-focused roles.

Learning aims

In this unit, you will:

A Investigate contemporary scientific issues that impact society and the environment

B Examine the effect different organisations have on contemporary science

C Understand how to report scientific information.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Investigate contemporary scientific issues that impact society and the environment	**A1** Scientific issues **A2** Implications of scientific issues **A3** Using and interpreting secondary data	Pearson Set Assignment.
B Examine the effect different organisations have on contemporary science	**B1** Governmental and global organisations **B2** Non-governmental organisations (NGOs) **B3** Governmental and global organisations	
C Understand how to report scientific information	**C1** Reporting of scientific information **C2** Scientific information **C3** Presenting scientific information	

Content

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

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

A1 Scientific issues

- Climate change, to include:
  - anthropogenic causes and effects
  - measures to mitigate change
  - measures to reach carbon neutrality: non-carbon energy sources, renewables, biofuels, carbon capture, AI in climate modelling.
- Food security, to include:
  - modern farming methods, e.g. precision agriculture (drone sensors)
  - genetic modification, e.g. disease-resistant crops, stress-tolerant crops
  - animal welfare, e.g. advanced technology for real-time monitoring
  - land use and conservation, e.g. restoration of ecosystems.
- Clean energy, to include:
  - lithium/solid-state batteries
  - tidal and wave power, solar power, wind power
  - hydrogen fuel cells
  - nuclear/hydroelectric power.
- Health for all, to include:
  - regenerative medicine, stem cell therapy, AI in diagnostics
  - health promotion, vaccination, antimicrobial resistance
  - digital health (telemedicine, wearables)
  - preparing for pandemics.
- Medical treatments, to include:
  - proton beam/stem cell therapy
  - AI-driven drug discovery
  - remote robotic surgery
  - personalised medicine.

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.

A3 Using and interpreting secondary data

- Evaluating the quality and reliability of secondary data, i.e. checking the source (who collected the data, when and how and for what purpose – author credibility and reliability of methodology); relevance, currency and consistency with other sources; accuracy; ethics – fairness, integrity and dignity

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 climate bodies.
- Executive/Government/State departments:
  - health/pandemic response
  - environment/land
  - food/agriculture
  - research/innovation.
- Other regulatory authorities/compliance agencies:
  - environment
  - food
  - medicines, healthcare, social care
  - digital security.

 © Pearson Education Limited 2026

B2 Non-governmental organisations (NGOs)

- Professional/non-profit organisations:
  - scientific associations, e.g. Royal Society of Biology, Royal Society of Chemistry, Institute of Physics
  - natural/environmental associations, e.g. Royal Society
  - medical/health associations
  - universities/centres of higher education and publicly funded research organisations
  - tech advisory groups, e.g. AI ethics, digital rights.
- Pressure Groups, trusts and charities:
  - environment/conservation, e.g. Greenpeace, Friends of the Earth, national parks
  - health, e.g. World Health Organization (WHO), British Red Cross, Family Planning Association, Global Health Partnerships
  - research/advocacy organisations, e.g. citizen science networks, think tanks, global youth climate movements.

B3 Businesses including multinationals, Big Tech companies

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

Learning aim C: Understand how to report scientific information

C1 Reporting of scientific information

- Reporting media:
  - specialist or peer-reviewed journals
  - podcasts, science influencers
  - online news – local, national and international
  - on-demand content, documentaries, film and television series
  - social media.
- The target audience:
  - general public
  - online/social groups, including different age/generations, social activities
  - scientific community
  - pressure groups/lobbyists
  - policy makers.

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/algorithmic bias
  - references and authenticity/peer review
  - data privacy
  - fact-checking platforms
  - 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 unbiased information.
- Differentiating between quantity and quality of scientific information.
- Use of visuals, graphics, data visualisation/dashboards for interpretation.
- Level of referencing, sources of information and use of the Harvard or Vancouver citation referencing system.
- Evidence to support conclusions/claims made.
- Critical validation of evidence to support or refute conclusions presented in scientific information.
- The importance of public understanding of science presented to them.

Assessment criteria

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

Pass	Merit	Distinction
A.P1 Research a selected scientific issue, using valid and reliable sources, to collate secondary data. [EL – SRS] **A.P2** Describe the effects on society of a scientific development. **A.P3** Describe the effects on the environment of a scientific development.	**A.M1** Explain the effects of a scientific development on society and the environment.	**A.D1** Evaluate the effects of a scientific development on society and the environment.

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

Pass	Merit	Distinction
B.P4 Use relevant information to build ideas and arguments about the role of governmental organisations in connection with contemporary scientific issues. **B.P5** Use relevant information to build ideas and arguments about the role of non-governmental organisations (NGOs) in connection with contemporary scientific issues. **B.P6** Use relevant information to build ideas and arguments about the role of business in connection with contemporary scientific issues.	**B.M2** Explain the impacts that different organisations have on a contemporary scientific issue.	**B.D2** Evaluate the impacts that different organisations have on a contemporary scientific issue.

Learning aim C: Understand how to report scientific information

Pass	Merit	Distinction
C.P7 Summarise conclusions on a contemporary scientific issue. **C.P8** Explain how a scientific issue is reported and presented for different audiences. **C.P9** Explain how reporting of contemporary scientific issues can be interpreted as valid and reliable.	**C.M3** Discuss a contemporary scientific issue for a general audience.	**C.D3** Evaluate a contemporary scientific issue for a professional audience.

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 a part of wider teaching and learning
√	Embedded in teaching, learning and assessment
blank	Not embedded or signposted in unit

Essential information for Pearson Set Assignment (PSA)

Pearson sets the assignment for the assessment of this unit.

The PSA will take 10 hours to complete.

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

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

Assessing the PSA

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

Section 1 gives information on PSAs, 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 diverse range of relevant scientific literature and information sources.

Essential information for assessment decisions

Learning aim A

For distinction standard, students provide secure evidence and evaluate two developments by weighing benefits, risks, adjustments and distributional effects with explicit, justified judgements. They interrogate validity and reliability, compare multiple high-quality sources, and address counterarguments using evidence strength (e.g., meta-analyses versus commentary). They distinguish between short- and long-term consequences, including rebound effects and opportunity costs. The student discusses uncertainty transparently, identifies who gains or loses and why, and synthesises social, economic, ethical and environmental perspectives. Conclusions are proportionate to the evidence base, acknowledge limitations, and propose reasoned implications for policy, practice or behaviour. Any information presented integrates accurate terminology, correctly formatted references and concise visuals, each interpreted to support the line of reasoning rather than to decorate it.

For merit standard, students provide secure evidence and explain how two developments lead to specific social and environmental consequences, linking mechanisms to outcomes with comparative data or cited examples. They demonstrate how scale (household to national) and timeframe (immediate to long-term) shape impacts and integrate relevant ethical or economic data. Explanations draw on triangulated sources to show patterns (e.g. how renewable adoption affects employment profiles while improving air quality). Students will comment on the limitations of datasets or reporting, while still advancing balanced, coherent arguments. Visuals are purposeful and interpreted rather than merely presented. Writing remains in the third person and is logically structured, demonstrating a connected understanding of scientific principles, technologies and observable changes in people, places and ecosystems.

For pass standard, students provide secure evidence, select appropriate contemporary issues and collate secondary information from credible sources, showing how qualitative commentary and quantitative data relate to clear cause-and-effect statements. They consistently reference, use correct terminology and include simple, relevant visuals (e.g. charts of emissions trends) that match the narrative. The social and environmental implications are described clearly, specifying who is affected and how. The student distinguishes between fact and opinion, appropriately signals uncertainty, and demonstrates basic source checking (e.g. peer review, sample size). Work is written in the third person, is logically organised, and avoids overclaiming, indicating a sound grasp of what is happening and why it matters at local and global scales.

Learning aim B

For distinction standard, students provide secure evidence and evaluate organisational impacts by comparing effectiveness, unintended consequences and fairness across contexts. They scrutinise evidence quality and potential conflicts of interest, assessing whether strategies (incentives, standards, philanthropy, public–private partnerships) achieve the intended scientific and societal outcomes. The student contrasts approaches across geographies or populations, articulates where and why outcomes diverge, and proposes justified recommendations. Discussion of accountability, transparency and stakeholder perspectives is explicit and properly sourced. Conclusions are nuanced, proportionate to evidence strength, and demonstrate independent judgement about how organisational configurations best support beneficial scientific progress while mitigating harms.

For merit standard, students provide evidence that is secure and explains the specific impacts of contrasting organisations, with clear mechanism–outcome links (e.g. regulation changing industry practices; advocacy shifting public behaviour; funding priorities directing research). They integrate examples across sectors such as health, energy and environment, showing how decisions alter adoption rates, equity of access or environmental metrics. Interdependencies are acknowledged (e.g. policy enabling corporate innovation supported by NGO scrutiny). Explanations are supported by triangulated evidence and, when helpful, concise visuals. The narrative remains balanced and analytical, demonstrating how organisational choices create measurable or well-reasoned effects on contemporary scientific issues and the communities they touch. Third-person reporting and consistent referencing are maintained throughout.

For pass standard, students provide secure evidence, gather pertinent information about governmental bodies, global agencies, NGOs and businesses, and construct reasoned points that connect roles (policy, regulation, funding, advocacy, market provision) to contemporary issues. They name relevant examples appropriately and show how activities, such as standard-setting, compliance, research grants, campaigns or investment influence the direction or uptake of scientific work. Arguments are logically sequenced and supported with cited sources. The student demonstrates awareness that organisations interact rather than act in isolation and that public outcomes (e.g. access to treatments, environmental performance) stem from these interactions. Writing is in third person, clearly structured and focused on how organisational functions shape scientific activity and its societal reach.

Learning aim C

For distinction standard, students provide evidence that is secure and delivers a rigorous appraisal for professional readers, interrogating methodology, statistics and reproducibility. They evaluate validity and reliability, compare multiple peer-reviewed sources, and identify misinformation or biased framing with evidence-based rebuttals. Terminology is precise, and referencing is consistent (Harvard or Vancouver) and comprehensive. Data visualisations are interpreted critically, with commentary on their uncertainties, limitations and alternative explanations. The student grades the strength of evidence, synthesises findings into defensible conclusions, and proposes clear implications for practice or further research. Writing remains concise, objective and third person, demonstrating a command of the critical validation required to support or refute claims in scientific reporting.

For merit standard, students provide secure evidence and deliver a rigorous appraisal for professional readers, interrogating methodology, statistics and reproducibility. They evaluate validity and reliability, compare multiple peer-reviewed sources, and identify misinformation or biased framing with evidence-based rebuttals. Terminology is precise, and referencing is consistent (Harvard or Vancouver) and comprehensive. Data visualisations are interpreted critically, with commentary on their uncertainties, limitations and alternative explanations. The student provides evidence linked to strength, synthesises findings into defensible conclusions, and proposes clear implications for practice or further research. Writing remains concise, objective and third person, demonstrating a command of the critical validation required to support or refute claims in scientific reporting.

For pass standard, students provide secure evidence and explain how an issue is communicated across media and audiences, noting differences in depth, terminology and the use of visuals. They identify features that influence trust – sample size, selection bias, peer review, referencing and framing – and show how these features influence interpretation by the public, social groups and the scientific community. The student outlines how style (past tense, passive voice, third person) supports clarity and objectivity and illustrates how credible graphics aid understanding. They comment on the correct and consistent use of Harvard or Vancouver referencing and indicate how misuse of data or misinformation can mislead readers, offering brief, sourced examples to anchor the analysis.

 © Pearson Education Limited 2026

Links to other units

The assessment for this unit will draw upon some of the underpinning knowledge, understanding and skills covered in:

- Unit 6: Health Challenges and Medical Innovations
- Unit 7: Chemical Principles and Reaction Systems
- Unit 8: Physics for Energy, Materials and Communication.

Unit 6: Health Challenges and Medical Innovations

Level: 3

Unit type: Pearson Set Assignment

Guided learning hours: 60

Unit in brief

This unit explores psychological and physiological disorders, their treatments, and the development of innovative medicines.

Unit introduction

Understanding the effects and treatments of psychological disorders and physiological diseases is increasingly important as mental and physical health challenges gain wider recognition. This unit provides essential knowledge about common conditions, their impact on daily life and the value of effective treatment. By studying both psychological and physiological issues, students develop empathy, critical thinking and a holistic view vital for health and social care careers.

The unit explores causes, symptoms and progression of psychological disorders such as anxiety, eating disorders and OCD, alongside physiological diseases including cancer, heart disease and diabetes. You will study treatments ranging from psychotherapy and medication to immunotherapy and gene editing. Content also considers treatment effects, emerging technologies like AI, and the ethical, social and professional implications of healthcare innovation.

Completing this unit builds analytical and evaluative skills valued in further study and employment. Students learn to interpret evidence, assess treatment options and weigh ethical considerations, supporting progression into psychology, biomedical sciences, nursing or health and social care. The focus on real-world practice and innovation enhances employability by strengthening adaptability, problem solving and forward-thinking abilities.

Learning aims

In this unit, you will:

A Understand effects and treatments of psychological disorders

B Understand effects and treatments of physiological diseases

C Examine innovation in treatments and techniques.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Understand effects and treatments of psychological disorders	**A1** Psychological disorders **A2** Treatments for psychological disorders **A3** Wider effects on the body	Pearson Set Assignment.
B Understand effects and treatments of physiological diseases	**B1** Physiological diseases **B2** Treatments for physiological diseases and disorders **B3** Wider effects on the body	
C Examine innovation in treatments and techniques	**C1** Innovative treatments and use of artificial intelligence (AI) **C2** Innovative techniques and use of AI **C3** Medical contexts on ethical, social and professional issues	

 © Pearson Education Limited 2026

Content

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

Learning aim A: Understand effects and treatments of psychological disorders

A1 Psychological disorders

- Causes, symptoms, diagnostic indicators, prognosis, progression and impact on daily life:
  - Anxiety, e.g. generalised anxiety disorder, panic disorder, specific phobias (claustrophobia, agoraphobia)
  - eating disorders, e.g. anorexia nervosa, bulimia nervosa
  - obsessive-compulsive disorder
  - depression.

A2 Treatments for psychological disorders

- Types of treatment and intended outcomes, therapies and associated benefits:
  - psychotherapy (e.g. cognitive behavioural therapy (CBT), dialectical behaviour therapy (DBT), psychodynamic therapy)
  - lifestyle interventions (e.g. exercise, sleep hygiene, nutrition)
  - exposure therapy, virtual reality exposure therapy
  - medication (e.g. antidepressants, antipsychotics, mood stabilisers, anxiolytics)
  - electroconvulsive therapy (ECT) (for severe depression or treatment-resistant conditions)
  - neurofeedback and brain stimulation, e.g. transcranial magnetic stimulation (TMS).

A3 Wider effects on the body

- Possible effects on the body of the treatments listed above:
  - positive effects (advantages and benefits), e.g. symptom reduction/remission, improved quality of life, enhanced coping skills and resilience
  - negative effects (disadvantages, potential harm), e.g. side effects of medications, emotional distress during therapy
  - risks associated with treatments, e.g. medication interactions or dependency, treatment-resistant symptoms, adverse reactions to ECT/TMS.

Learning aim B: Understand effects and treatments of physiological diseases

B1 Physiological diseases

- Causes, definition, symptoms, diagnostic indicators, prognosis, progression and impact on daily life of specified diseases:
  - cancer – prostate, cervical, breast, lung
  - diabetes – diabetes mellitus types 1 and 2
  - heart disease – hypertension, atherosclerosis, coronary heart disease (CHD)
  - obesity – metabolically healthy obesity, metabolically unhealthy obesity, normal weight obesity.

B2 Treatments for physiological diseases and disorders

- Types of treatments and intended outcomes, therapies and the associated benefits:
  - radiotherapy, including brachytherapy
  - chemotherapy
  - hormone therapy
  - surgery
  - targeted biological therapy and immunotherapy, e.g. monoclonal antibody therapy, angiogenesis inhibitors, T-cell therapy
  - gene therapy, e.g. replacing a mutated gene, inactivating a mutated gene, introducing a new gene stem, cell therapy.

B3 Wider effects on the body

- Possible effects on the body of the treatments listed above:
  - positive effects (advantages and benefits), e.g. partial cure, cure, quality of life
  - negative effects (disadvantages, potential harm), e.g. side effects of treatments
  - risks associated with treatments, e.g. exposure to increased levels of radioactivity during radiotherapy.

Learning aim C: Examine innovation in treatments and techniques [MY – TPR]

Innovation in treatments and techniques is essential to overcome limitations of current approaches, improve cost-effectiveness, and enhance efficiency, safety and outcomes for diverse patient needs.

C1 Innovative treatments and use of artificial intelligence (AI)

- Drug development:
  - computer modelling and big data analytics:
    - target identification
    - predicting drug efficacy
    - predicting toxicity
    - predicting patient response

  - speed and scalability:
    - comparison to traditional drug development
  - creating personalised medicine.
- Biotechnology and molecular medicine:
  - gene therapy
  - CAR T-cell therapy for cancer
  - monoclonal antibodies for autoimmune disorders
  - CRISPR-based gene editing for inherited disorders
  - mRNA-based treatments.
- Personalised medicine:
  - tailoring treatments to genetic profiles.
- Regenerative medicine:
  - stem cell therapy
  - tissue engineering.
- Digital health and AI:
  - remote monitoring
  - predictive diagnostics.

C2 Innovative techniques and use of artificial intelligence (AI)

'Innovative techniques' refer to new methods or approaches used in diagnosis, monitoring, treatment delivery or research. They are typically process-focused, enhancing how care or investigation is carried out.

- Surgical techniques:
  - less invasive ways to remove cells and tissues
  - nanoparticle delivery systems for targeted drug release
  - robotic-assisted surgery.
- 3D bioprinting of tissues.
- Wearable biosensors.
- Digital twin technology.
- Computer modelling using algorithms in clinical trials.
- AI-assisted diagnostic imaging.

C3 Medical contexts on ethical, social and professional issues

Issues relating to treatments, drug development and testing.

- Ethical, social and professional rules:
  - confidentiality, data protection, cyber security
  - informed consent and autonomy
  - rights of individual versus rights of society
  - do no harm
  - ‘can it be done?’, ‘should it be done?’.
- Replacement of animal testing with validated alternatives.
- Use of placebos.
- Use of blind and double-blind clinical trials.
- AI governance and biases.

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

Assessment criteria

Learning aim A: Understand effects and treatments of psychological disorders

Pass	Merit	Distinction
A.P1 Explain causes and effects of psychological disorders. **A.P2** Describe current treatments for psychological disorders.	**A.M1** Analyse associated effects of treatments of psychological disorders on the human mind.	**A.D1** Evaluate the choice and effects of treatments for a selected psychological disorder.

Learning aim B: Understand effects and treatments of physiological diseases

Pass	Merit	Distinction
B.P3 Explain causes and effects of physiological diseases. **B. P4** Describe current treatments for physiological diseases.	**B.M2** Analyse associated effects of treatments for physiological diseases on the human body.	**B.D2** Evaluate the choice and effects of treatments for a selected physiological disease.

Learning aim C: Examine innovation in treatments and techniques

Pass	Merit	Distinction
C.P5 Describe innovative treatment for physiological and psychological diseases/disorders. **C.P6** Compare development of two different drugs and/or medicines.	**C.M3** Discuss issues that can arise during the development and testing of an innovative treatment.	**C.D3** Evaluate issues of treatments for a selected drug or medicine development.

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 a part of wider teaching and learning
√	Embedded in teaching, learning and assessment
blank	Not embedded or signposted in unit

 © Pearson Education Limited 2026

Essential information for Pearson Set Assignment (PSA)

Pearson sets the assignment for the assessment of this unit.

The PSA will take 6 hours to complete.

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

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

Assessing the PSA

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

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

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- Up-to-date textbooks and reference materials on psychological and physiological disorders, treatments and medical innovations.
- Access to medical case studies, clinical reports and real-world examples of diagnosis and treatment innovations.
- Digital resources, including videos, interactive simulations and reputable online databases for drug development and ethical issues.

Essential information for assessment decisions

Learning aim A

For distinction standard, students critically evaluate the rationale behind selecting specific treatments for a chosen psychological disorder, considering a range of factors that influence decision making. They compare the effectiveness, suitability and limitations of various interventions, such as psychotherapy, medication and brain stimulation, taking into account individual needs, treatment-resistant symptoms and ethical considerations. The evaluation includes discussion of the balance between benefits and risks, the potential for adverse reactions, and the importance of tailoring treatment to the individual. The student's work is supported by well-chosen, detailed examples and demonstrates a sophisticated understanding of how treatment choices are made in clinical practice. Their evaluation reflects an awareness of the broader context, including social, ethical and practical implications for both patients and practitioners.

For merit standard, students provide a detailed and thoughtful analysis of how different treatments for psychological disorders affect the human mind and behaviour. They explore the benefits and limitations of therapies such as cognitive behavioural therapy, medication and electroconvulsive therapy, considering both intended outcomes and possible adverse effects. Students discuss how these treatments can improve quality of life, enhance coping skills or present risks such as emotional distress or medication dependency. Their analysis is supported by examples that illustrate the complexity of treatment effects, and they demonstrate an ability to connect treatment choices with psychological and physiological outcomes. The student's work reflects a deeper understanding of the interplay between disorder, treatment and individual experience, showing insight into the challenges faced by those living with psychological conditions.

For pass standard, students demonstrate a secure understanding by clearly outlining the main causes, symptoms and diagnostic features of psychological disorders such as anxiety, eating disorders, obsessive-compulsive disorder and depression. They accurately describe how these conditions may develop and progress, referencing the impact on daily life and prognosis. The student identifies a range of current treatments, including various forms of psychotherapy, medication and lifestyle interventions, and provides examples of how these approaches can help manage symptoms. Their work shows awareness of both the positive and negative effects of treatment, such as symptom reduction or potential side effects. Evidence is presented through relevant, real-world examples, and the student's explanations are factually correct, demonstrating a sound grasp of the key concepts and terminology related to psychological disorders and their management.

Learning aim B

For distinction standard, students evaluate the decision-making process involved in selecting treatments for a specific physiological disease, considering a range of clinical and personal factors. They assess the comparative effectiveness, risks and benefits of available therapies, such as surgery, immunotherapy and targeted biological treatments, and discuss how these choices are influenced by prognosis, patient preferences and ethical considerations. The evaluation addresses both the clinical perspective and the lived experience of patients, including the impact on quality of life and the potential for long-term side effects. The student's work is thorough, well-argued, and demonstrates a high level of insight into the complexities of treatment choice, reflecting an understanding of the broader context in which decisions are made.

For merit standard, students analyse the effects of treatments for physiological diseases on the human body, considering both the positive and negative outcomes. They discuss the benefits of interventions, such as improved prognosis, symptom management and enhanced quality of life, as well as the potential risks and side effects, such as exposure to radioactivity or adverse reactions to medication. The analysis includes consideration of how different treatments may be more or less suitable depending on the disease, stage and individual patient factors. The student uses examples to support their points and demonstrates an ability to weigh up the outcomes of different treatment options, showing a deeper understanding of the complexities involved in managing physiological diseases.

For pass standard, students explain the causes, symptoms and progression of physiological diseases such as cancer, diabetes, heart disease and obesity. They describe how these diseases develop, the diagnostic indicators used to identify them, and the impact on daily life and prognosis. The student outlines a range of current treatments, including surgery, chemotherapy, radiotherapy and gene therapy, and provides examples of how these interventions can benefit or harm the body. Their explanations are clear and demonstrate a sound understanding of the basic concepts, including both the advantages and disadvantages of treatment. The student's work shows an ability to relate theoretical knowledge to real-world situations, using appropriate terminology and examples to illustrate their points.

Learning aim C

For distinction standard, students evaluate issues related to the development of a selected drug or medicine. This involves making reasoned judgements supported by evidence, considering the impact of these issues on patients, healthcare systems and society. Students weigh benefits against risks, addressing ethical, legal and social implications, and explore potential solutions or recommendations for responsible development. The evaluation demonstrates a depth of understanding, critical thinking and the ability to synthesise information from multiple perspectives. Evidence is well-structured, balanced and shows clear justifications for conclusions drawn, reflecting a high level of analytical and evaluative skill.

For merit standard, students provide a detailed discussion of issues that can arise during the development and testing of an innovative treatment. This includes ethical considerations, such as informed consent, animal testing alternatives and patient safety, as well as practical and regulatory challenges like cost, time and compliance with legal frameworks. Students explain why these issues are significant and how they can affect the progress and success of treatment development. The discussion demonstrates understanding of artificial intelligence use and the complexity of innovation in healthcare and shows the ability to link issues to real-world implications for patients and society.

For pass standard, students produce a clear and structured comparison of the development of two different drugs or medicines. The comparison identifies and describes the main stages in each development process, such as discovery, pre-clinical testing, clinical trials and regulatory approval. Students highlight similarities and differences between the two examples, demonstrating understanding of how scientific and technological methods influence development. Evidence is factual, accurate and supported by appropriate terminology. While depth of analysis is not required, the work must show a logical structure and sufficient detail to illustrate the processes involved in both cases.

Links to other units

The assessment for this unit will draw upon some of the underpinning knowledge, understanding and skills covered in:

- Unit 1: Principles and Applications of Biology
- Unit 13: Human Disease, Infection and Environmental Health.

Unit 7: Chemical Principles and Reaction Systems

Level: 3

Unit type: Pearson Set Assignment

Guided learning hours: 60

Unit in brief

The unit explores periodicity, energetics, kinetics, equilibrium and green chemistry alongside organic mechanisms and synthesis, developing deep understanding of chemical behaviour and reaction systems principles.

Unit introduction

Understanding how chemical systems behave underpins modern science, industry and sustainability. This unit equips learners with the core chemical principles needed to interpret material properties, predict reaction behaviour and evaluate chemical processes. Knowledge of periodic trends, energy changes, reaction rates and equilibrium is essential for informed decision-making in areas such as materials selection, energy production, pharmaceuticals, and environmentally responsible chemical manufacture.

The unit develops depth across physical, inorganic and organic chemistry. Learners investigate Period 3 trends and reactivity, building links between structure, bonding and properties. They explore chemical energetics and kinetics, including enthalpy changes, Hess cycles, rate equations and Maxwell–Boltzmann distributions. Equilibrium concepts are linked to quantitative calculation and green chemistry principles, while organic content covers halogenoalkanes, alcohols and reaction mechanisms, culminating in synthesis and evaluation of organic compounds.

This unit provides a strong theoretical foundation for progression to further chemistry-based study and applied science pathways. It supports transition to advanced units, including application-focused chemistry and specialist STEM qualifications, and develops analytical, problem-solving and evaluative skills valued in laboratory, technical and scientific employment.

Learning aims

In this unit, you will:

A Investigate how properties of elements change in the periodic table

B Understand chemical energetics and kinetics in chemical reactions

C Understand chemical equilibrium and green chemistry in chemical reactions

D Understand further principles of organic chemistry.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Investigate how properties of elements change in the periodic table	**A1** Trends across Period 3 elements **A2** Reactions of Period 3 elements **A3** Acid-base behaviour of Period 3 oxides and chlorides	Pearson Set Assignment.
B Understand chemical energetics and kinetics in chemical reactions	**B1** Chemical energetics **B2** Chemical kinetics **B3** Maxwell–Boltzmann distribution and reaction rates	
C Understand chemical equilibrium and green chemistry in chemical reactions	**C1** Dynamic equilibrium in chemical systems **C2** Equilibrium calculations and interpretation **C3** Principles and applications of green chemistry	
D Understand further principles of organic chemistry	**D1** Chemistry of halogenoalkanes **D2** Chemistry of Alcohols **D3** Synthesis and mechanisms in organic chemistry	

 © Pearson Education Limited 2026

Content

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

Learning Aim A: Investigate how properties of elements change in the Periodic Table

Care must always be taken when working with hazardous substances. The use of personal protective equipment, correct controls and storage, and prevention of fire and environmental pollution must underpin all practical activities.

A1 Trends across Period 3 elements

- Atomic radius:
  - definition and measurement
  - trend across Period 3 (decreases left to right)
  - explanation – nuclear charge versus shielding
  - impact on chemical reactivity.
- Melting point:
  - variation across metals, metalloids, non-metals
  - structure-property relationship (metallic, giant covalent, molecular)
  - explanation of peaks and troughs
  - examples: Na, Mg, Al, Si, P, S, Cl, Ar.
- Electrical conductivity:
  - conductors versus insulators in Period 3
  - role of delocalised electrons
  - comparison – metals vs. non-metals
  - practical applications, e.g. electrical wiring, power transmission, semiconductors, batteries.
- Summary table of trends:
  - visual summary of atomic radius, melting point, conductivity
  - key exceptions and explanations
  - links to periodic law
  - importance for predicting properties.

A2 Reactions of Period 3 elements

- Reaction with oxygen:
  - types of oxides formed (basic, amphoteric, acidic)
  - balanced equations for each element

  - oxidation states and numbers
  - observed properties (colour, state, solubility).
- Reaction with water:
  - elements that react (Na, Mg, Al)
  - products formed (hydroxides, hydrogen gas)
  - balanced equations
  - trends in reactivity.
- Reaction with chlorine:
  - formation of chlorides (ionic vs. covalent)
  - balanced equations
  - oxidation numbers
  - physical and chemical properties of chlorides.
- Oxidation numbers:
  - definition and rules
  - assigning oxidation numbers in reactions
  - redox changes in Period 3 reactions
  - importance in chemical equations.

A3 Acid-base behaviour of Period 3 oxides and chlorides

- Structure and bonding:
  - ionic versus covalent oxides/chlorides
  - lattice versus molecular structures
  - link to acid-base properties
  - examples: Na_2O (basic), SO_3 (acidic).
- Acidic, basic and amphoteric oxides:
  - definitions and examples
  - reactions with acids and bases
  - amphoteric behaviour (Al_2O_3)
  - practical implications.
- Hydrolysis of chlorides:
  - reaction with water
  - pH of resulting solutions
  - explanation using structure and bonding
  - environmental considerations, e.g. water/soil acidity, corrosion, toxic by-products, heavy metals in soil.

- Linking structure to properties:
  - how structure determines acid-base behaviour
  - trends across the period
  - predicting properties of unknown compounds
  - application in industrial and laboratory settings, e.g. basic oxide in glass manufacturing, acidic oxide in laboratory glassware, amphoteric oxide in water treatment, hydrolysis in chemical synthesis.

Learning Aim B: Understand chemical energetics and kinetics in chemical reactions

B1 Chemical energetics

- Endothermic and exothermic reactions:
  - definitions and examples
  - energy profile diagrams
  - practical demonstrations
  - everyday examples (combustion, photosynthesis).
- Enthalpy changes:
  - standard enthalpy definitions (formation, combustion, neutralisation)
  - measuring enthalpy changes (calorimetry)
  - Hess's Law and energy cycles
  - calculations using enthalpy data.
- Hess Energy cycles:
  - constructing energy cycles
  - using cycles to calculate unknown enthalpy changes
  - application to real reactions
  - common pitfalls and errors.
- Interpreting enthalpy data:
  - using data tables
  - comparing theoretical and experimental values
  - sources of error
  - importance in industrial chemistry.

B2 Chemical kinetics

- Factors affecting rate of reaction:
  - concentration, temperature, surface area, catalysts
  - collision theory
  - experimental investigation
  - real-world examples.

- Rate equations:
  - definition and form of rate equations
  - determining order of reaction
  - calculating rate constants
  - graphical methods (rate vs. concentration).
- Orders of reaction:
  - zero, first and second order
  - experimental determination
  - half-life calculations
  - implications for reaction mechanisms.
- Activation energy and catalysis:
  - definition of activation energy
  - effect of catalysts
  - Maxwell–Boltzmann distribution curves
  - industrial applications, e.g. Haber Process in ammonia synthesis, catalytic converters, hydrogenation of vegetable oils.

B3 Maxwell–Boltzmann distribution and reaction rates

- Distribution curves:
  - shape and interpretation
  - effect of temperature on distribution
  - area under the curve (number of particles)
  - link to activation energy.
- Effect of temperature:
  - increased temperature and particle energy
  - impact on rate of reaction
  - shifts in distribution curve
  - practical implications.
- Effect of concentration and catalysts:
  - more particles, more collisions
  - lowering activation energy
  - changes in rate with/without catalyst
  - examples from industry, e.g. ammonia production for fertilisers, sulphuric acid production, polyethylene manufacture.

Pearson BTEC International Level 3 Qualifications in Applied Science –
Issue 1 – March 2026 © Pearson Education Limited 2026

- Assessing reaction conditions:
  - optimising temperature, concentration, catalyst use
  - balancing rate and yield
  - environmental and economic considerations, e.g. energy efficiency and emissions, waste minimisation, increased productivity, process optimisation.

Learning Aim C: Understand chemical equilibrium and green chemistry in chemical reactions [MY – TPR]

C1 Dynamic equilibrium in chemical systems

- Definition and characteristics:
  - closed systems and reversible reactions
  - constant concentrations of reactants/products
  - observable properties at equilibrium.
- Le Chatelier's Principle:
  - predicting effects of changes in concentration, pressure, temperature
  - shifts in equilibrium position
  - industrial examples (e.g. Haber Process).

C2 Equilibrium calculations and interpretation

- Equilibrium constants (K_c, K_p):
  - definitions and calculation methods
  - units and significance of values
  - interpreting changes with temperature.
- Quantitative problem solving:
  - ICE tables for concentration changes
  - stepwise calculation of equilibrium concentrations
  - common errors and troubleshooting.

C3 Principles and applications of green chemistry

- Principles of green chemistry:
  - atom economy, waste minimisation, energy efficiency
  - safer solvents and reaction conditions
  - use of renewable feedstocks.
- Industrial applications and evaluation:
  - case studies, e.g. pharmaceutical synthesis, polymer production
  - metrics for green chemistry (environmental (E)-factor, atom economy)
  - environmental, economic and regulatory considerations.

Learning Aim D: Understand further principles of organic chemistry

D1 Chemistry of halogenoalkanes

- Structure, formation and nomenclature:
  - general formula and naming conventions
  - methods of formation (free radical substitution, addition)
  - isomerism and physical properties.
- Reactivity and mechanisms:
  - nucleophilic substitution and elimination reactions
  - factors affecting reactivity (structure, solvent, leaving group)
  - environmental and practical aspects (uses, hazards).

D2 Chemistry of alcohols

- Structure and classification:
  - primary, secondary, tertiary alcohols
  - functional group identification and physical properties.
- Formation and reactions:
  - methods of synthesis (hydration of alkenes, fermentation)
  - oxidation, dehydration, substitution, esterification
  - industrial and laboratory uses, e.g. solvents for manufacturing, fuels and energy, synthesis of chemicals, reagents in organic synthesis, chromatography and sample preparation, preservation and fixation.

D3 Synthesis and mechanisms in organic chemistry

- Addition, substitution and elimination mechanisms:
  - curly arrow notation and stepwise mechanisms
  - examples for each type (examples involving alkenes, halogenoalkanes, alcohols).
- Synthesis of organic liquids:
  - planning synthetic routes and choosing reagents
  - purification, yield calculation and waste management
  - evaluating atom economy and environmental impact.

 © Pearson Education Limited 2026

Assessment criteria

Learning aim A: Investigate how properties of elements change in the periodic table

Pass	Merit	Distinction
A.P1 Explain changes in atomic radius, melting point and electrical conductivity across Period 3 elements.	**A.M1** Discuss reactions of selected Period 3 elements with oxygen, water and chlorine, using balanced equations and oxidation numbers.	**A.D1** Assess the acid-base behaviour of Period 3 oxides and chlorides, linking structure to observed chemical properties.

Learning aim B: Understand chemical energetics and kinetics in chemical reactions

Pass	Merit	Distinction
B.P2 Investigate endothermic and exothermic reactions. **B.P3** Explain factors that affect rate of reaction.	**B.M2** Calculate enthalpy changes for a range of reactions using Hess energy cycles. **B.M3** Deduce rate equations for chemical reactions, including orders of reaction and calculation of rate constants.	**B.D2** Assess the effects of temperature, concentration and catalysis on reaction rate and activation energy using Maxwell–Boltzmann distribution curves.

Learning aim C: Understand chemical equilibrium and green chemistry in chemical reactions

Pass	Merit	Distinction
C.P4 Investigate factors that affect systems in dynamic equilibrium. **C.P5** Explain the principles of green chemistry.	**C.M4** Carry out calculations involving equilibrium constants and interpret changes in values with temperature.	**C.D3** Evaluate industrial applications in terms of physical chemistry concepts and green chemistry considerations.

 © Pearson Education Limited 2026

Learning aim D: Understand further principles of organic chemistry

Pass	Merit	Distinction
D.P6 Review the chemistry of halogenoalkanes and their formation. **D.P7** Review the chemistry of alcohols and their formation. **D.P8** Carry out the synthesis of an organic liquid.	**D.M5** Construct mechanisms for addition, substitution and elimination reactions.	**D.D4** Evaluate the synthesis of an organic liquid.

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 a part of wider teaching and learning
√	Embedded in teaching, learning and assessment
blank	Not embedded or signposted in unit

Essential information for Pearson Set Assignment (PSA)

Pearson sets the assignment for the assessment of this unit.

The PSA will take 6 hours to complete.

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

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

Assessing the PSA

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

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

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- Safety equipment – personal protective equipment (PPE), first aid kits, fire extinguishers and spill control.
- Core apparatus – glassware, measuring instruments and heating devices.
- Chemical and biological materials – reagents, samples and consumables.

Essential information for assessment decisions

Learning aim A

For distinction standard, students critically assess the acid-base behaviour of Period 3 oxides and chlorides, linking structural features to chemical properties. Evidence includes safe analysis of ionic and covalent bonding, lattice and molecular structures, and how these influence reactions with acids and bases. The student explains amphoteric behaviour, hydrolysis and environmental implications, using examples such as Al_2O_3 and SO_3. Their work demonstrates the ability to predict the properties of unknown compounds and to apply these concepts to industrial and/or laboratory contexts.

For merit standard, students provide detailed accounts of reactions involving selected Period 3 elements with oxygen, water and chlorine. Evidence includes accurate, balanced equations, identification of products, and assignment of oxidation numbers. The student discusses observed properties such as colour, state and solubility, and explains how these relate to the reactivity of each element. Their work demonstrates a capacity to compare and contrast different types of oxides and chlorides, and to interpret chemical changes in terms of electron transfer and oxidation states.

For pass standard, students demonstrate understanding by describing observable trends in atomic radius, melting point and electrical conductivity across Period 3 elements. Evidence includes clear explanations of how these properties change from sodium to argon, supported by reference to underlying factors such as nuclear charge and electron shielding. The student uses examples to illustrate differences between metals, metalloids and non-metals, and relates these trends to practical applications, such as electrical wiring or material selection. Their work shows an ability to summarise and interpret data, using tables or diagrams to reinforce their explanations.

Learning aim B

For distinction standard, students assess the effects of temperature, concentration and catalysis on reaction rate and activation energy, using Maxwell–Boltzmann distribution curves. Evidence includes interpreting distribution shapes, explaining shifts due to temperature or catalysts, and applying these principles to industrial processes. The student evaluates reaction conditions for optimisation, considering environmental and economic impacts such as energy efficiency, emissions and waste minimisation.

For merit standard, students calculate enthalpy changes for a range of reactions using Hess's law, demonstrating proficiency in constructing energy cycles and applying them to real reactions. Evidence includes accurate calculations, interpretation of enthalpy data, and identification of sources of error. The student deduces rate equations, determines orders of reaction, and calculates rate constants using graphical methods, showing a systematic approach to experimental data and theoretical concepts.

For pass standard, students investigate endothermic and exothermic reactions by describing energy changes and providing everyday examples. Evidence includes the use of energy profile diagrams and practical demonstrations, showing understanding of how energy is absorbed or released. The student explains factors affecting reaction rates, such as concentration, temperature, surface area and catalysts, and relates these to collision theory and real-world scenarios.

Learning aim C

For distinction standard, students evaluate industrial applications in terms of physical chemistry concepts and green chemistry considerations. Evidence includes analysis of case studies, assessment of atom economy and E-factor, and discussion of environmental, economic and regulatory impacts. The student demonstrates a holistic understanding of how equilibrium and green chemistry principles are applied to optimise industrial processes.

For merit standard, students carry out calculations involving equilibrium constants (Kc, Kp) and interpret changes in values with temperature. Evidence includes accurate use of ICE tables, stepwise calculation of equilibrium concentrations, and discussion of units and significance. The student demonstrates the ability to troubleshoot common errors and to interpret quantitative data in context.

For pass standard, students investigate factors affecting dynamic equilibrium, describing how changes in concentration, pressure or temperature influence the equilibrium position. Evidence includes reference to Le Chatelier’s Principle and examples from industrial processes. The student explains principles of green chemistry, such as atom economy and waste minimisation, and relates these to safer solvents and renewable feedstocks.

 © Pearson Education Limited 2026

Learning aim D

For distinction standard, students evaluate the synthesis of an organic liquid, considering purification, yield calculation and waste management. Evidence includes assessment of atom economy, environmental impact and practical implications for industrial and laboratory settings. The student demonstrates the ability to plan synthetic routes, select appropriate reagents and critically appraise the efficiency and sustainability of the process.

For merit standard, students construct mechanisms for addition, substitution and elimination reactions, using curly arrow notation and stepwise explanations. Evidence includes accurate representation of reaction pathways for alkenes, halogenoalkanes and alcohols, as well as a discussion of factors affecting reactivity. The student shows understanding of how mechanisms relate to product formation and reaction conditions.

For pass standard, students review the chemistry of halogenoalkanes and alcohols, describing their formation, structure and physical properties. Evidence includes identification of functional groups, explanation of nomenclature, and discussion of synthesis methods such as free radical substitution and fermentation. The student synthesises an organic liquid, demonstrating practical skills in planning and executing laboratory procedures.

Links to other units

The assessment for this unit will draw upon some of the underpinning knowledge, understanding and skills covered in

- Unit 2: Principles and Applications of Chemistry.

Unit 8: Physics for Energy, Materials and Communication

Level: 3

Unit type: Pearson Set Assignment

Guided learning hours: 60

Unit in brief

This unit explores thermal physics, material properties, fluid dynamics, radioactivity and electromagnetism, linking theory to practical applications in energy systems, manufacturing, healthcare and communication technologies.

Unit introduction

This unit relates directly to real-world applications of thermal physics, material properties, fluid dynamics, radioactivity and electromagnetism, all central to modern technology and industry. These principles influence energy-efficient heating, structural safety, medical imaging and power generation. Studying them helps students understand how scientific knowledge supports innovation, sustainability and safe practice in domestic and industrial settings.

The unit covers thermal physics topics such as energy transfer, gas laws and heat engines. It examines material behaviour through properties, stress–strain relationships, elasticity and failure. Fluid dynamics includes viscosity and Bernoulli's principle, while radioactivity focuses on detection, applications and risks. Electromagnetism covers fields, induction, transformers and electromagnetic waves, linking theory to practical technologies.

Completing this unit develops essential analytical and scientific skills, supporting progression into applied sciences, physics and engineering. It also prepares students for careers in energy, manufacturing, healthcare technology or telecommunications. Understanding these principles strengthens problem-solving abilities and enables students to contribute to innovation.

Learning aims

In this unit, you will:

A Understand thermal physics, materials and fluids

B Investigate radioactivity and its uses

C Examine the principles and applications of electromagnetism.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Understand thermal physics, materials and fluids	**A1** Thermal physics in domestic and industrial applications **A2** Materials in domestic and industrial applications **A3** Fluids in motion	Pearson Set Assignment.
B Investigate radioactivity and its uses	**B1** Radioactive emissions **B2** Applications of radioactivity	
C Examine the principles and applications of electromagnetism	**C1** Electric fields and forces **C2** Magnetic fields and electromagnetic forces **C3** Electromagnetic induction and energy transfer **C4** Electromagnetic waves and communication	

Content

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

Learning Aim A: Understand thermal physics, materials and fluids

A1 Thermal physics in domestic and industrial applications

- Be able to use the following quantities and units:
  - power, watt (W), kilowatt (kW), megawatt (MW), gigawatt (GW)
  - convert °C to K
  - pressure (Pascals (Pa), Newton per metre squared (Nm^{-2})).
- Know the following definitions:
  - work done as energy transferred
  - work done as force × distance moved in direction of force ($W = F \times \Delta x$)
  - work done by a gas as pressure × change in volume of gas ($W = p \times \Delta V$).
- Be able to calculate efficiency using the relationships:
  - efficiency = useful energy output/total energy input
  - for heat engines:

    efficiency = $1 - \frac{Q_{out}}{Q_{in}}$

    maximum theoretical efficiency= $1 - \frac{T_C}{T_H}$
- Understand the following concepts:
  - gas laws, Boyle, Charles and pressure, Ideal Gas Law $\mathrm{pV} = \mathrm{NkT}$
  - law of conservation of energy, first law of thermodynamics ($Q = \Delta U + W$)
  - isothermal and adiabatic processes
  - idealised engine cycles, Carnot and Otto
  - second law of thermodynamics
  - heat engines, including internal combustion engines
  - heat pumps and refrigerators
  - maximum theoretical coefficient of performance (COP).

A2 Materials in domestic and industrial applications

- Understand the following concepts and apply them in domestic and industrial applications:
  - elasticity
  - stress–strain curves
  - elastic limit
  - strength
  - yield point
  - plastic deformation
  - creep
  - fatigue
  - ductility
  - brittleness
  - malleability
  - elastic hysteresis.
- Be able to use the following quantities and units:
  - density kgm^{-3}
  - tensile/compressive stress (Newton per metre squared (Nm^{-2}))
  - tensile/compressive strain (no units)
  - Young's modulus (Newton per metre squared (Nm^{-2})).
- Understand the following definitions:
  - density ρ = m

$$\rho = \frac{m}{v}$$

  - tensile/compressive stress =

$$\frac{F}{A}$$

  - tensile/compressive strain =

$$\frac{\Delta x}{L}$$

  - Young's modulus *E* = stress/strain
  - Hooke's law $F = k\Delta x$
  - work done in stretching/compressing a wire/spring, Elastic strain energy,

$$\Delta E(el) = \frac{1}{2}F\Delta x = \frac{1}{2}k(\Delta x)^2$$

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

A3 Fluids in motion

Understand the following concepts and apply them in industrial and domestic situations:

- Fluid flow patterns, streamline and turbulent flow.
- Viscosity.
- Viscous drag.
- Mass of fluid flow per second for all points along a pipe or stream tube is constant.
- Non-Newtonian fluid flow, e.g. Oobleck.
- Rate of fluid flow and pressure.
- Bernoulli's principle.
- Case study – heat exchange for an industrial process.

Learning aim B: Investigate radioactivity and its uses

B1 Radioactive emissions

- Radioactive decay, transforming the nucleus.
- Radioactive half-life.
- Alpha, beta and gamma radiations, and their relative compositions, properties and masses.
- Transforming the nucleus – alpha and beta decay principles.
- Nuclear fission principles.
- Detection of alpha, beta and gamma radiation.
- Health hazards and radiation dosimeter badges in industry.
- Compliance with laws and regulations that ensure safe working with radiation.
- Background radiation – natural sources (e.g. radon gas, cosmic rays) and human-developed sources (e.g. buildings, medical uses as tracers, nuclear power, food and drink industry).
- Case study – dealing with nuclear power station accidents.

B2 Applications of radioactivity

- Nuclear power – generating thermal energy by splitting the nucleus of uranium-235.
- Radiocarbon dating of rocks younger than 60,000 years and radioisotope dating of older rocks.
- Radioactive tracers in medical diagnosis and industrial flow monitoring.
- Production of plutonium for nuclear weapons.

Learning aim C: Examine the principles and applications of electromagnetism
[MY – TPR]

C1 Electric fields and forces

- Concept of electric charge, types of charge, the law of conservation of charge.
- Definitions and units for electrical charge (coulomb, C), electrical field strength (newton per coulomb, N/C or volt per metre, V/m), potential difference (volt, V).
- Electric field lines (point charges, parallel plates, dipoles).
- Calculation of the force between two-point charges using Coulomb's law:

$$F = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r^2}$$

- Concept of electrical potential and potential energy in an electric field.
- Applications, e.g. electrostatic precipitators, photocopiers, industrial paint spraying.

C2 Magnetic fields and electromagnetic forces

- The concept of magnetic fields, magnetic flux density (tesla, T), magnetic field lines.
- Definition and units for magnetic flux (weber, Wb), magnetic flux density (tesla, T), current (ampere, A).
- Magnetic field around a current-carrying wire, solenoid, bar magnet.
- Use of Fleming's left-hand rule to predict the direction of force on a current-carrying conductor in a magnetic field.
- Calculation of the force on a conductor:

$$F = BIL\sin\theta$$

- Health and safety associated with high voltages, strong magnetic fields, electromagnetic radiation.
- Applications, e.g. electric motors, loudspeakers, maglev trains.

C3 Electromagnetic induction and energy transfer

- Faraday's law and Lenz's law of electromagnetic induction.
- Definitions and units for induced emf (volt, V), rate of change of magnetic flux (weber per second, Wb/s).
- How step-up, step-down transformers work.
- Calculation of transformer output using:

$$\frac{V_p}{V_8} = \frac{N_p}{N_8}$$

- Applications, e.g. power transmission, wireless charging, induction cookers.

C4 Electromagnetic waves and communication

- Electromagnetic spectrum (ratio, microwave, infrared, visible, ultraviolet, X-ray, gamma rays).
- Properties of electromagnetic waves (speed, frequency, wavelength, energy).
- How electromagnetic waves are produced and detected.
- Applications, e.g. mobile/cell phones, radio and television transmitters, Wi-Fi, satellite communications, medical imaging (MRI).
- Case study – managing electromagnetic interference in hospitals and data centres.

Assessment criteria

Learning aim A: Understand thermal physics, materials and fluids

Pass	Merit	Distinction
A.P1 Explain power, pressure, and energy relationships with unit conversions and calculations.	**A.M1** Analyse materials' stress-strain behaviour, elasticity and failure modes, linking properties to realistic industrial applications.	**A.D1** Discuss the importance of thermal physics, materials and fluids to industrial situations.

Learning aim B: Investigate radioactivity and its uses

Pass	Merit	Distinction
B.P2 Describe alpha, beta, gamma radiations, half-life and detection methods linked to industrial examples. **B.P3** Explain background radiation sources and occupational dosimetry, linked to health risks.	**B.M2** Analyse radioactive applications, including nuclear power and tracers, demonstrating coherent calculations and realistic constraints effectively.	**B.D2** Evaluate the uses of radioactivity in terms of benefits and risks.

Learning aim C: Examine the principles and applications of electromagnetism

Pass	Merit	Distinction
C.P4 Describe electric charge, fields, potential and Coulomb's law, demonstrating accurate field representations and calculations with correct units. **C.P5** Explain magnetic fields, flux density and forces on conductors, applying Fleming's rule with clear diagrams.	**C.M3** Analyse electromagnetic induction and transformer operation, calculating induced emf and realistic power transmission performance.	**C.D3** Evaluate the uses of electromagnetism in terms of benefits and risks.

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 a part of wider teaching and learning
√	Embedded in teaching, learning and assessment
blank	Not embedded or signposted in unit

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

Essential information for Pearson Set Assignment (PSA)

Pearson sets the assignment for the assessment of this unit.

The PSA will take 6 hours to complete.

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

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

Assessing the PSA

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

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

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- Laboratory equipment: thermometers, pressure gauges, calorimeters and basic fluid-flow apparatus.
- Material testing tools: tensile testing rig, stress–strain demonstration samples and measuring instruments.
- Radiation and detection kits: demonstration Geiger–Müller counter, radioactive source simulation software and dosimeter badges.
- Electromagnetism apparatus: power supplies, coils, magnets, transformers, oscilloscopes and induction kits.

Essential information for assessment decisions

Learning aim A

For distinction standard, students will evaluate the significance of thermal physics, materials and fluid dynamics in domestic and industrial systems. They will discuss how energy conservation, heat transfer and material properties influence design and efficiency, considering sustainability and cost implications. Evidence will include critical discussion supported by examples, such as heat pumps, refrigeration systems and structural materials, demonstrating an integrated understanding of physics principles and their application to practical solutions.

For merit standard, students will analyse stress–strain behaviour of materials, interpreting elasticity, yield points and failure modes. They will link these properties to practical applications, such as structural components or household products, explaining why material selection matters. Evidence will include annotated diagrams, comparative analysis of materials and discussion of performance under load, creep or fatigue, showing how these characteristics affect safety, durability and efficiency in real-world scenarios.

For pass standard, students will demonstrate understanding by performing accurate calculations involving power, pressure and energy relationships, including conversions between units. They will explain principles and phase transitions in industrial processes. Evidence will include correct use of equations, clear workings and application to realistic industrial contexts.

Learning aim B

For distinction standard, students will critically evaluate the benefits and risks of radioactivity in different contexts, balancing advantages such as energy production and medical diagnostics against hazards such as contamination and long-term waste storage. Evidence will include structured arguments supported by case studies, safety considerations and environmental impacts, demonstrating a nuanced understanding of how societal needs and safety concerns shape the use of radioactivity technologies.

For merit standard, students will analyse applications of radioactivity, such as nuclear power generation, medical tracers and/or industrial monitoring. They will perform coherent calculations, for example, estimating decay rates or energy output, and discuss practical constraints like shielding and waste management. Evidence will include worked examples, reasoned analysis and realistic considerations of efficiency, safety and regulatory compliance in applying radioactive technologies.

For pass standard, students will describe alpha, beta and gamma radiation, their properties and detection methods, linking these to industrial and/or medical examples. They will refer to half-life and background radiation sources, including natural and artificial origins, and outline occupational safety measures such as dosimetry. Evidence will include labelled diagrams and examples of real-world applications, demonstrating awareness of health risks and monitoring practices.

Learning aim C

For distinction standard, students will evaluate the applications of electromagnetism, considering benefits such as efficient energy transfer and advanced communication systems, alongside risks like electromagnetic interference and health concerns. Evidence will include critical discussion supported by examples from power distribution, wireless technologies and medical imaging, demonstrating awareness of technological, safety and societal implications of electromagnetic systems.

For merit standard, students will analyse electromagnetic induction and transformer operation, applying Faraday's and Lenz's laws to calculate induced emf and assess power transmission performance. They will explain how design factors affect efficiency and losses in real systems. Evidence will include detailed calculations, annotated diagrams and discussions of safe practical improvements, such as reducing eddy currents or using high-voltage transmission for energy conservation.

For pass standard, students will describe electric charge, fields and potential, applying Coulomb's law with accurate calculations and diagrams. They will refer to magnetic fields, flux density, and forces on conductors, using Fleming's left-hand rule to predict motion. Evidence will include labelled field representations, correct units, and worked examples showing understanding of electromagnetic principles in practical scenarios.

Links to other units

The assessment for this unit will draw upon some of the underpinning knowledge, understanding and skills covered in:

- Unit 3: Principles and Applications of Physics
- Unit 3: Real-World Scientific Mathematics
- Unit 5: Contemporary Science Issues.

Unit 9: Practical Scientific Procedures and Techniques

Level: 3

Unit type: Internal

Guided learning hours: 60

Unit in brief

This unit develops students' ability to apply practical scientific techniques in biology, chemistry and physics with accuracy and responsibility.

Unit introduction

This unit applies directly to real-world settings by developing practical skills needed to prepare, analyse and investigate scientific solutions, biological samples and physical systems. Accurate measurement, safe working and responsible equipment use are essential in laboratory, environmental and industrial contexts. Understanding these practices highlights how science supports healthcare, engineering, environmental monitoring and energy industries.

The unit introduces a wide range of scientific principles and techniques. You will learn solution preparation, titration and purity testing in chemistry, developing precision and evaluative skills. Biological work includes colourimetry, component concentration studies and ecological fieldwork with data collection and analysis. Physics content covers cooling curves, circuits and renewable energy, linking theory with practical experimentation.

Completing this unit strengthens transferable skills essential for further study and employment. Students develop independence, responsibility and problem-solving abilities valued across scientific and technical careers. The unit offers a strong foundation for progression into laboratory science, environmental research, healthcare, biotechnology and engineering, supporting readiness for both academic advancement and professional practice.

Learning aims

In this unit, you will:

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

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

C Undertake physical procedures responsibly to examine energy transfer.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Undertake techniques responsibly to prepare solutions and determine concentrations and purity	**A1** Laboratory equipment and its calibration **A2** Preparation and standardisation of solutions using titration **A3** Techniques to determine the purity of organic compounds	Report of outcomes from practical procedures in chemistry.
B Undertake procedures responsibly to investigate the concentration and distribution of biological components	**B1** Colorimetry **B2** Plant growth	Report of outcomes from practical procedures in biology.
C Undertake physical procedures responsibly to examine energy transfer	**C1** Transfer of thermal energy **C2** Transfer of energy through electrical circuits **C3** Transfer of energy from a renewable resource	Report of outcomes from practical procedures in physics.

Content

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

Learning aim A: Undertake techniques responsibly to prepare solutions and determine concentrations and purity

Responsibilities and standard of behaviors relevant to roles, e.g. as a student or on roles relevant to science.

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.
- Importance of achievable time management, including health and well being, and setting realistic goals.

A3 Techniques to determine purity of organic compounds

- 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) and 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.

Learning aim B: Undertake procedures responsibly to investigate concentration and distribution of biological components [MY – TPR]

How to plan resource use, including identifying resource needs and arranging timely access to resources, following sustainability practices.

B1 Colorimetry

Understanding and practical application of colourimetry techniques.

- Selection and use of a colourimeter or visible spectrometer – selection of filter (colourimeter) 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 a 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 responsibly to examine energy transfer [MY – TPR]

Definition of accountability and ways to demonstrate accountability, fulfilling responsibilities for their role; taking responsibility for mistakes; being open to feedback.

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 its 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.
- Specific heat capacity of water, determining 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.
- Diameters of five wires of the same material but with different cross-sectional areas.
- Resistivity of the material used for the wires.
- 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.
- Solar cell construction investigation.
- Use of circuits to determine the voltage output of a solar panel under different conditions.
- Production of quantitative data to find relationships between voltage output and distance from source, angle of solar panel, light intensity and light colour.
- Optimum conditions needed to achieve the maximum voltage reading and relate this to power generation.

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

Assessment criteria

Learning aim A: Undertake techniques responsibly to prepare solutions and determine concentrations and purity

Pass	Merit	Distinction
A.P1 Demonstrate the correct use and calibration of balances and volumetric glassware for accurate measurements. **A.P2** Responsibly prepare primary standard solutions and titration techniques to calculate concentrations. [MY – TPR]	**A.M1** Analyse the reliability of titration results by discussing concordant titres, systematic errors and uncertainty.	**A.D1** Evaluate effectiveness of techniques used and accountability of concentration and purity outcomes.

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

Pass	Merit	Distinction
B.P3 Demonstrate the use of colourimetry to prepare calibration curves and determine concentrations of unknown solutions. **B.P4** Responsibly investigate plant distribution and growth using ecological sampling techniques, including quadrats and microscopy. [MY – TPR]	**B.M2** Analyse the accuracy and limitations of colourimetry and ecological sampling methods when investigating biological components.	**B.D2** Assess the significance of environmental and biological factors in influencing plant growth and biodiversity distribution.

Learning aim C: Undertake physical procedures responsibly to examine energy transfer

Pass	Merit	Distinction
C.P5 Investigate cooling curves, electrical circuits and renewable energy using energy transfer experiments. **C.P6** Construct and measure series and parallel electrical circuits responsibly using ammeters and voltmeters. [MY – TPR]	**C.M3** Analyse experimental data to identify factors affecting cooling curves, electrical circuit resistance and output of solar panels.	**C.D3** Evaluate effectiveness of techniques used and accountability of energy transfer outcomes.

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 a part of wider teaching and learning
√	Embedded in teaching, learning and assessment
blank	Not embedded or signposted in unit

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments. There is also further information on our website.

There is a maximum number of 3 summative assignments for this unit.

The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aim: B (B.P3, B.P4, B.M2, B.D2)

Learning aim: C (C.P5, C.P6, C.M3, C.D3)

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- A suitably equipped laboratory.
- Materials/equipment and/or laboratory instruments/sensors that will enable them to carry out practical work.
- Appropriate science and mathematics software to help students present their data.

Essential information for assessment decisions

Learning aim A

For distinction standard, students evaluate the effectiveness of techniques for solution preparation and purity determination, making well-justified comparisons. Their evidence shows independence in judgement, linking results to scientific practice while maintaining a responsible approach to laboratory safety and method selection. They highlight strengths, weaknesses and propose refinements, demonstrating accountability for outcomes. Their evaluative work reflects responsible autonomy in applying advanced techniques and ensuring validity, accuracy and ethical working in laboratory contexts.

For merit standard, students demonstrate analysis of how their measurements and outcomes are affected by procedural factors. They reflect on reliability and accuracy, showing structured reasoning in their evidence. Responsible work is evident in their consistent approach to handling equipment and in their consideration of potential errors. Their work demonstrates accountability, as they provide information on how improvements could strengthen accuracy, ensuring results remain valid, relevant and safe for laboratory application.

For pass standard, students correctly describe their practical preparation of solutions and the use of titration techniques. They handle balances, volumetric glassware and calibration procedures responsibly, showing care in measurement and safety. Explanations of the work carried out demonstrate an essential understanding of concentrations, purity checks and valid results. Evidence reflects systematic working with awareness of accountability, producing reliable outcomes through appropriate laboratory practice most of the time and safe compliance with scientific expectations.

Learning aim B

For distinction standard, students evaluate their biological investigations, showing independence and accountability when making judgements on overall effectiveness. They consider how environmental and biological factors influence results, comparing evidence with expectations. Responsible work is demonstrated through careful management of ethical and safety practices. Evidence reflects critical thinking, as students highlight strengths and weaknesses and propose improvements to enhance the validity, reliability and sustainability of biological methods and conclusions for wider scientific application.

For merit standard, students analyse the quality of their investigations and the accuracy and reliability of colourimetric and ecological results. Evidence demonstrates accountable working, with clear reasoning on the limitations of techniques. Their approach shows responsibility in interpreting calibration curves and ecological data, ensuring results are explained logically. They demonstrate consideration of how scientific principles are applied responsibly to ensure accuracy and relevance in biological investigations.

For pass standard, students describe their use of practical skills when conducting colourimetric and ecological investigations, selecting safe methods to produce meaningful results. Their evidence shows the application of procedures, including the preparation of calibration curves and biological observations. They maintain accountability by working systematically and recording data accurately most of the time. Valid results indicate that students can apply techniques responsibly, following safe practices while explaining biological concentration and plant distribution.

Learning aim C

For distinction standard, students evaluate energy transfer investigations critically, showing independence and responsibility in assessing effectiveness. They provide well-supported judgements on methods and outcomes, linking results to broader scientific and real-world contexts such as renewable energy. Responsible working is demonstrated through safe, accurate and accountable practice. Their evidence highlights strengths, weaknesses and proposed improvements, reflecting critical thinking and autonomy in ensuring reliability, validity and ethical responsibility within advanced physical science investigations.

For merit standard, students analyse results responsibly, identifying how factors such as resistance, cooling rates or solar panel conditions influence outcomes. Evidence shows accountability in recognising the limitations of their methods and explaining their reliability. Their approach demonstrates responsible use of equipment and logical interpretation of patterns. They consider how working practices and accuracy support valid conclusions, highlighting the importance of responsibility in maintaining safe, effective and reliable energy transfer investigations.

For pass standard, students describe their energy transfer experiments, including cooling curves, circuits and renewable energy tasks. They record results appropriately most of the time and follow safe procedures, showing accountability in using equipment safely. The evidence reflects systematic working, with explanations of the scientific principles of energy transfer. Their responsible conduct ensures outcomes are valid and demonstrates awareness of how careful method selection contributes to reliability and safety in investigations.

Links to other units

The assessment for this unit will draw upon some of the underpinning knowledge, understanding and skills covered in:

- Unit 1: Principles and Applications of Biology
- Unit 2: Principles and Applications of Chemistry
- Unit 3: Principles and Applications of Physics
- Unit 6: Health Challenges and Medical Innovations
- Unit 7: Chemical Principles and Reaction Systems
- Unit 8: Physics for Energy, Materials and Communication.

Unit 10: Investigative Science Project

Level: 3

Unit type: Internal

Guided learning hours: 60

Unit in brief

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

Unit introduction

This unit develops inquiry and independent research skills essential in a science-driven society. The ability to design, conduct and evaluate investigations is vital for addressing real-world problems, making informed decisions and supporting scientific progress. Learning project planning, data analysis and scientific reporting prepares students for higher education and the workplace, where these skills are widely valued.

The unit covers a wide range of content, starting with creating a project proposal and hypothesis, then planning and scheduling work while considering health, safety and ethical requirements. You will carry out practical investigations, apply experimental techniques, collect and analyse data, and present results. Finally, you will produce a full scientific report and evaluate your findings.

Completing this unit provides a strong foundation for progression into science-related study or employment. Students gain transferable skills in project management, problem solving and communication, valued by universities and employers. Experience in independent research, critical evaluation and scientific reporting equips learners for success in higher education and for careers in laboratory work, research or applied science sectors.

Learning aims

In this unit, you will:

A Plan independently for an investigative science project based on a proposal and focused on own learning objectives

B Organise time and resources to safely undertake the project, collecting, analysing and presenting the results

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

Summary of unit

Learning aim	Key content areas	Assessment approach
A Plan independently for an investigative science project based on a proposal and focused on own learning objectives	**A1** Project scheduling **A2** Project planning **A3** Health and safety and ethical considerations	Investigative Science Project Plan.
B Organise time and resources to safely undertake the project, collecting, analysing and presenting the results	**B1** Experimental procedures and techniques **B2** Collect, collate and analyse data **B3** Data presentation	Investigative Science Project Logbook, including data, visuals and evidence of practical work.
C Present the conclusions from the project using correct scientific principles	**C1** Scientific report for the investigative project **C2** Scientific evaluation of findings **C3** Skills development within project work	Investigative Science Project Report or Presentation.

Content

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

Learning aim A: Plan independently for an investigative science project based on a proposal and focused on own learning objectives

A1 Project scheduling

Timeline for the project, to include:

- Start date.
- Completion date.
- Scheduling.

A2 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.
- Meaning of independent learning, i.e. students having ownership of their learning.

A3 Health and safety and ethical considerations

- Identification of hazards, to include:
  - personal protective equipment (PPE)
  - control 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 B: Organise time and resources to safely undertake the project, collecting, analysing and presenting the results

B1 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.

B2 Collect, collate and analyse data

Becoming a successful independent student: organisation of time and resources; metacognitive skills; understanding own learning styles; self-regulation; motivation and commitment:

- 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.

B3 Data presentation

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

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

C1 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.

C2 Scientific evaluation of findings

- Validation of methods 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.

C3 Skills development within project work

Reviews and applies learning from successful and unsuccessful outcomes to be effective in subsequent tasks:

- 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

Learning aim A: Plan independently for an investigative science project based on a proposal and focused on own learning objectives

Pass	Merit	Distinction
A.P1 Propose an investigative science project with focus on own learning objectives. [EL – MOL]	**A.M1** Propose in detail an investigative science project with testable hypothesis and potential limitations.	**A.D1** Justify approach, hypothesis, data collected, analysis techniques and considerations for an investigative science project.

Learning aim B: Organise time and resources to safely undertake the project, collecting, analysing and presenting the results

Pass	Merit	Distinction
B.P2 Assemble relevant apparatus/equipment and materials for an investigative science project. **B.P3** Safely carry out investigative procedures and techniques, demonstrating ability to work independently to complete tasks, where appropriate. [EL-MOL]	**B.M2** Safely use investigative procedures and techniques to collect, collate and analyse accurate data and information to test hypotheses.	**B.D2** Review the effectiveness of procedures and techniques carried out, recommending appropriate improvements.

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

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

Pass	Merit	Distinction
C.P4 Report findings, using scientific terminology and protocol. **C.P5** Present conclusions and summary of skills developed in the investigative science project.	**C.M3** Comprehensively report on findings, using correct scientific terminology, protocol and formatting. **C.M4** Discuss conclusions and the importance of skills developed in meeting the project's objectives.	**C.D3** Evaluate conclusions of the investigative science project, its practical aspects, discussing limitations and justifying suggestions for improvements for future projects.

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 a part of wider teaching and learning

√ Embedded in teaching, learning and assessment

blank Not embedded or signposted in unit

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments. There is also further information on our website.

There is a maximum number of 2 summative assignments for this unit based on one investigative project outcome.

The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.M1, A.D1)

Learning aim: B (B.P2, B.P3, B.M2, B.D2)

Learning aim: C (C.P4, C.P5, C.M3, C.M4, C.D3)

Further information for teachers and assessors

Resource requirements

There are no specific resource requirements for this unit.

Essential information for assessment decisions

Learning aim A

For distinction standard, students will justify their project proposal – their choice of investigation, the hypothesis they will test and how they will test it. They will explain how their hypothesis is valid and measurable, and how the investigation will build on existing literature instead of replicating it. The students will also justify their plan and the methods they will use, including how they will present their results and test their significance. They will provide coherent and logical reasons for the choices they have made regarding methods, resources or other variables. Students will show that they have considered more than one appropriate investigative approach to tackling the hypothesis and explain why they have chosen their selected approach.

For merit standard, students will produce a hypothesis that can be tested practically, using the available facilities. They will demonstrate an understanding of the potential limitations of their proposed investigation, such as the accuracy of graduated apparatus or the limitations of instruments and sensors. The student's plan must be realistic and must enable the hypothesis to be tested correctly. It will include contingency planning (for example, if a sensor/instrument stops working or if a test or experiment yields unexpected or inaccurate results). The proposal, hypothesis and plan will require only minimal intervention by the tutor.

For pass standard, students must 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 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 is achievable, safe and ethical.

Learning aim B

For distinction standard, students will assess the effectiveness of their project plan. They will show how they reflected on feedback from others on 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 to be modified, again using examples to support their decision. When (as is likely) internal or external factors require changes during the investigation itself – e.g. adjustments to the timeline, equipment or methods used – students must justify these changes, explaining how they are expected to improve the project's outcomes.

For merit standard, students will carry out their practical work safely and with minimal intervention. They will perform tasks 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 they use. This is likely to include 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 identify incorrect measurements, responding appropriately. They will revise practical approaches, plan to improve the project's outcomes, and justify these changes. The student will use the results of an appropriate statistical test to determine if their results are statistically significant. They can use provided worksheets, apps or spreadsheets for the statistical tests, but they need to be able to explain what the test means and the degree of confidence in the result.

For pass standard, students assemble the apparatus/equipment for their project and select appropriate materials before safely carrying out all procedures. Each student will provide robust evidence of work done, including annotated images of the student completing the work, a reflective account of what they have done (for example, in their laboratory log or notebook), a video of them working with explanatory commentary, or detailed Observation Records or Witness Statements specific to the student. Alternative methods are acceptable, provided they are specific to the student and provide clear evidence of how they 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 it 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 C

For distinction standard, students 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, incorporating feedback from others. Students will demonstrate how self-reflection and feedback (which could be obtained through collaborative work) have aided their project work, and also suggest areas for improvement and the steps necessary to achieve them.

For merit standard, students correctly interpret their results and statistical analysis. Unreliable results and their causes 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 project's findings will be correctly interpreted, leading to valid conclusions. Students will review the skills they have developed during their project, discussing how these skills improved and how they contributed to achieving the project's objectives.

For pass standard, students interpret the results of their investigation, stating whether their original objective has been met and whether their hypothesis has been proven, 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, in the passive voice and past tense. It will be conventionally formatted, with a title, an abstract, an introduction, materials and methods, results, discussion and conclusions, and a bibliography. Students will correctly describe the skills that they have developed during their project.

Links to other units

The assessment for this unit will draw upon some of the underpinning knowledge, understanding and skills covered in:

- Unit 1: Principles and Applications in Biology
- Unit 2: Principles and Applications in Chemistry
- Unit 3: Principles and Applications in Physics
- Unit 6: Health Challenges and Medical Innovations
- Unit 7: Chemical Principles and Reaction Systems
- Unit 8: Physics for Energy, Materials and Communication
- Unit 9: Practical Scientific Procedures and Techniques.

Unit 11: Energy Generation Challenges and Opportunities

Level: 3

Unit type: Internal

Guided learning hours: 60

Unit in brief

The unit explores fossil fuels and renewable energy sources, their environmental impacts, and their advantages and disadvantages. Students develop analytical skills and knowledge relevant to sustainability, technology and future energy challenges.

Unit introduction

This unit is relevant to real-world challenges, as energy production and environmental sustainability are central issues for society, industry and government. Students need to understand the environmental impacts of fossil fuels and the potential of renewable energy sources to make informed decisions as citizens, future professionals or innovators. Researching these concepts equips students to engage with debates on climate change, energy policy and technological advancements that shape our world.

The unit covers a broad and detailed range of content, including the extraction and use of fossil fuels, their environmental consequences, and the technologies behind renewable energy generation. You will explore the efficiency, advantages and disadvantages of various energy sources, including nuclear and biofuels. The curriculum encourages critical thinking about sustainability, reliability, economic factors and ecological impacts, providing a comprehensive foundation for understanding energy systems and their implications.

By completing this unit, students gain valuable knowledge and analytical skills that support progression to further study in science, engineering, or environmental disciplines. The unit also enhances employability by fostering awareness of current energy technologies and sustainability issues, both of which are increasingly important in many sectors. Students are better prepared to contribute to future developments in energy, environmental management, and policymaking.

Learning aims

In this unit, you will:

A Explore the environmental impact of fossil fuel use

B Explore the generation of electricity using renewable fuel sources

C Examine advantages and disadvantages of renewable energy.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Explore the environmental impact of fossil fuel use	**A1** Uses of coal and the by-products of coal, crude oil and natural gas **A2** Environmental impacts of fossil fuel use	Report or presentation on the sources and environmental impact of the use of fossil fuels.
B Explore the generation of electricity using renewable fuel sources	**B1** Renewable energy **B2** Nuclear energy **B3** Efficiency of energy production	Portfolio of evidence that considers alternative energy sources.
C Examine advantages and disadvantages of renewable energy	**C1** Advantages of generating energy from renewable resources **C2** Disadvantages of generating energy from renewable resources	Report or presentation that explores advantages and disadvantages of renewable energy.

Issue 1 – March 2026 © Pearson Education Limited 2026

Content

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

Learning aim A: Explore the environmental impact of fossil fuel use

Methods used in the extraction, mining and drilling of fossil fuels.

A1 Uses of coal and the by-products of coal, crude oil and natural gas

- Uses of coal:
  - steam coal (thermal coal) in power generation
  - coking coal (metallurgical coal) in steel production
  - carbon fibre – e.g. manufacture of bicycles, tennis rackets
  - activated carbon – water filters, kidney dialysis machines, air purification.
- Use of by-products of coal (coal tar):
  - creosote oil
  - naphthalene
  - phenol
  - Benzene
  - ammonia gas (ammonia salts, nitric acid, fertilisers)
  - soaps, dyes, nylon
  - aspirin
  - coal combustion products (CCPs) – e.g. fly ash in cement making.
- Crude oil as a fuel and as a base for other products:
  - fuels – gasoline, diesel, kerosene
  - tar, asphalt, paraffin wax
  - fertilisers, perfume, insecticides
  - plastics – PVC, textiles.
- Natural gas:
  - generation of electricity
  - cooking and heating
  - vehicle fuel
  - as a feedstock for products such as fertilisers and pharmaceutical products.

A2 Environmental impacts of fossil fuel use

- Global warming, the 'greenhouse effect':
  - emission of heat-trapping gases – carbon dioxide (CO_2), methane (CH_4), water vapour (H_2O)
  - rise in global temperatures, recorded data
  - rise in sea levels
  - risks of extreme weather (drought, heat waves, intensified storms)
  - ecological disruption (acid rain, threats to coastal areas, wildlife habitats).
- Toxic air pollutants:
  - mercury – linked to damage to human body systems and water pollution
  - sulphur dioxide – linked to asthma, bronchitis, acid rain, smog, damage to crops and ecosystems, acidification of lakes and streams
  - nitrous oxides – linked to smog, lung irritation
  - lead – accumulation in the body and consequent damage to body systems, decreased growth and reproductive rates in plants and animals, and neurological effects in vertebrates
  - arsenic – linked to contamination of air, water and soil
  - volatile organic compounds (VOCs) – linked to the formation of ground-level ozone
  - particulates (soot) – linked to lung disease.
- Extraction of oil and shale gas by hydraulic fracturing (fracking):
  - risk of earthquakes
  - leakage of fracking fluids into local aquifers
  - substantial use of water.

Learning aim B: Explore the generation of electricity using renewable fuel sources

Economic and operational factors that affect the advancement of renewable energy sources.

B1 Renewable energy

- Solar energy (Perovskite solar cells, solar skins for buildings, agrivoltaics).
- Wind energy – turbines, wind farms (onshore, offshore, floating), AI for turbine efficiency.
- Geothermal energy (enhanced geothermal systems, low-temperature geothermal for local heating).
- Hydroelectric energy (dams, fish-friendly turbines, climate resilience strategies).
- Biomass energy (use of waste biomass, deforestation).
- Tidal and wave energy (emerging technologies and pilot projects, integration with smart grids).

 © Pearson Education Limited 2026

B2 Nuclear energy

- Use of uranium, nuclear fission and chain reaction.
- Boiling-water, pressurised and gas-cooled reactors.
- Small Modular Reactors.
- Fusion research, nuclear waste innovations.

B3 Efficiency of energy production

- Levelised cost of energy (LCOE):
  - value of electrical energy generated
  - costs incurred – construction, operation and maintenance of power-generating plant
  - technology – design of more efficient systems used to capture energy
  - cost of fuel
  - cost of dealing with environmental damage.

Learning aim C: Examine advantages and disadvantages of renewable energy

Sustainability, reliability, cost of maintenance and environmental impacts.

C1 Advantages of generating energy from renewable resources

- Advantages of biofuels (wood, animal waste, ethanol, algae-based), sustainable crops/ forests, regenerative farming.
- Advantages of solar energy (economic savings, incentives, low maintenance, vertical solar panels).
- Advantages of wind energy (horizontal or vertical axis turbines, relatively small footprint, local employment).
- Advantages of hydroelectric energy (impoundment (dam), diversion and pumped storage).
- Advantages of tidal and wave energy (reliability, consistency, predictability).
- Creating green jobs and income for rural and urban communities.
- Free sources (wind, water, sun).
- Non-polluting, clean generation.

C2 Disadvantages of generating energy from renewable resources

- Initial investment costs.
- Operating costs.
- Inconsistent, unreliable supply (clouds, changing winds, water conflicts).
- Efficiency per square metre of land use.
- Use of large areas of land to install wind turbines or dams.

- Environmental impact of dams (creation of artificial reservoirs, change in habitat for aquatic plants and animals, blocking fish migration, alteration of sediment transport, changes to riparian zones).
- Use of large areas of land to grow biofuel crops.
- Use of pesticides to protect biofuel crops.
- Noise pollution (wind turbines).
- Visual impact.
- Harm to wildlife.
- Use of large quantities of freshwater (geothermal).
- Ease of storage (biomass).
- Destabilisation of marine systems.
- Hot spots from solar farms.

Assessment criteria

Learning aim A: Explore the environmental impact of fossil fuel use

Pass	Merit	Distinction
A.P1 Describe the sources and uses of oil, coal and natural gas energy. **A.P2** Describe how the use of fossil fuels impacts the environment.	**A.M1** Explain how the use of fossil fuels affects the environment.	**A.D1** Evaluate the impact of fossil fuels on the environment.

Learning aim B: Explore the generation of electricity using renewable fuel sources

Pass	Merit	Distinction
B.P3 Describe technologies used to generate renewable energy. **B.P4** Describe advantages and disadvantages of using nuclear fuels.	**B.M2** Compare the efficiency of different renewable energy sources.	**B.D2** Evaluate factors that affect the efficiency of methods used to generate renewable energy.

Learning aim C: Examine advantages and disadvantages of renewable energy

Pass	Merit	Distinction
C.P5 Describe advantages and disadvantages of increasing use of renewable energy sources.	**C.M3** Compare advantages and disadvantages of using renewable energy sources.	**C.D3** Evaluate benefits and drawbacks of increased use of renewable energy sources.

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 a part of wider teaching and learning

√ Embedded in teaching, learning and assessment

blank Not embedded or signposted in unit

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. The *Pearson BTEC International Level 3 Qualifications Supplementary Information* document gives information on setting assignments. There is also further information on our website.

There is a maximum number of 3 summative assignments for this unit.

The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aim: B (B.P3, B.P4, B.M2, B.D2)

Learning aim: C (C.P5, C.M3, C.D3)

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- Up-to-date textbooks and digital materials covering fossil fuels, renewable energy and environmental impacts.
- Access to case studies, scientific reports and real-world data on energy production and environmental consequences.
- Visual aids such as diagrams, infographics and videos illustrating extraction methods, energy generation and sustainability.

Essential information for assessment decisions

Learning aim A

For distinction standard, students assess the overall impact of fossil fuels, weighing the severity and scope of environmental damage across multiple dimensions. Accurate achievement is demonstrated when students evaluate evidence relating to various pollutants and ecological disruptions, reflecting on both immediate and long-term consequences for climate, wildlife and human populations. Their work should show a sophisticated understanding of interconnected environmental challenges, considering the cumulative effects of fossil fuel use and extraction. Evidence is interpreted through balanced analysis, use of scientific data or case studies, and reflection on the complexity of environmental impacts, including the role of law-making and policy. Students should demonstrate advanced analytical skills by considering future implications and proposing informed perspectives on mitigation or adaptation strategies.

For merit standard, students provide detailed explanations of how fossil fuel extraction and usage contribute to environmental issues, showing a clear understanding of cause and effect. Accurate evidence is demonstrated when students discuss mechanisms such as global warming, acid rain and toxic air pollutants, linking these to specific fossil fuel processes. Their work should reference how pollutants like mercury, sulphur dioxide, nitrous oxides and particulates impact ecological and human systems, and explain the processes that lead to these emissions. Achievement is interpreted through the ability to connect extraction methods and by-products to broader environmental consequences, supported by relevant examples and explanations. Students should show analytical thinking by discussing the relationships between fossil fuel use, pollutant release and the resulting environmental impacts, using case studies or data where appropriate.

Issue 1 – March 2026 © Pearson Education Limited 2026

For pass standard, students demonstrate achievement by identifying the main sources of fossil fuels and outlining their applications in energy generation and industry. Accurate evidence is shown when students reference specific uses of coal, oil and natural gas, including their roles in power generation, manufacturing and domestic settings. They should also show awareness of basic environmental consequences, such as pollution and greenhouse gas emissions, by mentioning particular pollutants and their effects on ecosystems and human health. Achievement is interpreted through clear descriptions of how fossil fuels are extracted and used, with examples drawn from the content areas. The work should reflect a foundational understanding of the topic, demonstrating that students can connect fossil fuel use to environmental change and provide relevant details about the types of pollutants involved.

Learning aim B

For distinction standard, students evaluate the complex factors affecting renewable energy efficiency, including economic, technological and environmental aspects. Accurate evidence is shown when students consider innovations, maintenance and the impact of integrating new systems, providing a balanced assessment of how these factors interact to influence overall energy generation outcomes. Their work should reflect a nuanced understanding of the challenges and opportunities in renewable energy, supported by critical analysis and reference to current developments. Achievement is interpreted through the ability to synthesise information from multiple sources, assess the interplay between cost, technology and environmental impact, and propose informed perspectives on future trends and improvements in renewable energy systems.

For merit standard, students compare the efficiency of different renewable energy sources, considering factors such as the levelised cost of energy, technological advancements and operational costs. Accurate achievement is indicated when students discuss how design, fuel costs and environmental considerations influence the effectiveness of each method. Their work should demonstrate analytical skills in evaluating energy production, supported by relevant comparisons and examples. Achievement is interpreted through the ability to weigh multiple factors, such as maintenance requirements, integration with smart grids, and the impact of innovations, and present reasoned analysis. Students should show understanding of how efficiency varies across technologies and the implications for energy policy and sustainability.

For pass standard, students show achievement by identifying and describing a range of renewable energy technologies, such as solar, wind, geothermal, hydroelectric, biomass, tidal and wave energy. Accurate evidence is provided when students outline basic operational principles for each technology and mention innovations or emerging trends, such as perovskite solar cells or AI for turbine efficiency. Their work should demonstrate familiarity with how these technologies contribute to electricity generation, referencing examples from the content areas. Achievement is interpreted through clear descriptions and appropriate use of terminology, showing that students understand the fundamental differences between renewable and non-renewable sources and can explain how renewable energy systems operate in practice.

Learning aim C

For distinction standard, students evaluate the overall benefits and costs of expanding renewable energy sources, considering long-term sustainability, economic implications and environmental impacts. Accurate achievement is demonstrated when students reflect on the balance between advantages and disadvantages, providing a nuanced analysis that considers future trends and potential challenges. Their work should show advanced evaluative skills, supported by critical reflection and reference to current and emerging issues, such as technological innovation, policy developments and global energy needs. Achievement is interpreted through the ability to synthesise complex information, assess the implications for society and the environment, and propose informed recommendations for the future of renewable energy.

For merit standard, students compare the environmental and financial advantages and disadvantages of two different renewable energy sources, considering aspects such as pollution, cost of maintenance, land use and resource sustainability. Accurate evidence is provided when students demonstrate the ability to weigh different perspectives and present a reasoned comparison, supported by examples and discussion of relevant factors. Achievement is interpreted through analytical skills, showing how the benefits and drawbacks of each energy source affect decision making in energy policy and practice. Students should discuss the trade-offs involved, such as the impact on ecosystems, economic viability and long-term sustainability, using case studies or data to support their analysis.

For pass standard, students describe the key benefits and drawbacks of increasing renewable energy use, referencing sustainability, reliability, maintenance and environmental impacts. Accurate achievement is indicated when students mention examples such as green jobs, clean generation and challenges like land use, initial costs and supply inconsistency. Their work should reflect a basic understanding of both positive and negative aspects, with clear references to content areas such as biofuels, solar, wind and hydroelectric energy. Achievement is interpreted through the ability to provide relevant examples and explanations, showing that students can identify the main factors influencing the adoption of renewable energy and recognise the practical implications for communities and the environment.

Links to other units

The assessment for this unit will draw upon some of the underpinning knowledge, understanding and skills covered in:

- Unit 1: Principles and Applications of Chemistry
- Unit 7: Chemical Principles and Reaction Systems
- Unit 15: Applications of Physical, Inorganic and Organic Chemistry.

Unit 12: Electrical Circuits and Measurement

Level: 3

Unit type: Internal

Guided learning hours: 60

Unit in brief

Students study electrical symbols, SI units, circuit construction and measurement techniques for both theoretical and practical application. The unit develops analytical, problem-solving and hands-on skills essential for technical careers.

Unit introduction

This unit links directly to real-world electrical and electronic applications, giving students the knowledge and practical skills needed in modern industry. Understanding electrical symbols, SI units and circuit principles supports work in engineering, technology and maintenance. Students learn to interpret technical documents, construct and troubleshoot circuits safely, and apply accurate measurement and safety practices essential in many technical fields.

The unit covers electrical symbols, key quantities and relationships between electrical properties. You will investigate series and parallel circuits, using mathematical and graphical methods to analyse their behaviour. Practical tasks include building circuits, measuring electrical values and comparing results with theory. The curriculum also addresses temperature effects, material choice and component tolerances for a thorough understanding.

Completing this unit provides a strong basis for further study in electrical engineering, electronics and related disciplines. Students develop analytical, problem-solving and practical skills using industry-standard equipment. These competencies enhance employability and prepare learners for apprenticeships, technician roles or higher education, enabling effective contribution across a wide range of professional technical environments.

Learning aims

In this unit, you will:

A Understand electrical symbols, SI units, definitions, relationships and properties of circuit components

B Construct series and parallel circuits for use in standard electrical applications

C Examine AC and DC production and safe working with electricity

D Examine the uses of transducers, sensors and other measurement devices.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Understand electrical symbols, SI units, definitions, relationships and properties of circuit components	**A1** Electrical symbols and SI units – their definitions and uses in applied scenarios **A2** Electrical formulae and relationships **A3** Electrical properties and uses of materials	Report or presentation and evidence of practical investigation with calculations and diagrams.
B Construct series and parallel circuits for use in standard electrical applications	**B1** Circuit characteristics **B2** Measurement devices	
C Examine AC and DC production and safe working with electricity	**C1** DC production **C2** AC production, three-phase systems and transmission **C3** Domestic applications and mains supply **C4** Safety, human physiology and electricity	Laboratory and research notes and evidence of practical investigation.
D Examine the uses of transducers, sensors and other measurement devices	**D1** Uses of passive transducers **D2** Uses of active transducers **D3** Sensors, instrumentation and data systems	Circuit construction and report or presentation on electrical measurements and applications.

Content

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

Learning aim A: Understand electrical symbols, SI units, definitions, relationships and properties of circuit components

A1 Electrical symbols and SI units – their definitions and uses in applied scenarios

- Symbols: cell, battery, switch, filament lamp, fixed resistor, thermistor, light-emitting diode (LED), light-dependent resistor (LDR), rheostat, capacitor, voltmeter, ammeter, diode, Zener diode, photo diode, phototransistor, opto-isolator, transistor (BJT/MOSFET) (as switching symbols), fuse, MCB/RCBO, RCD, ground/earth, inductor, transformer, bridge rectifier, USB-C PD source/sink, solar PV module, EV charge point, VFD block symbol.
- Definitions: current (ampere), potential difference (volt), electrical charge (coulomb), resistance (ohm), conductance (siemens, S), electrical power (watt), capacitance (farad and sub-units), inductance (henry, H), energy (joule, J), frequency (hertz, Hz), impedance (ohm, Ω), reactance (X_L, X_C), phase angle (ϕ), power factor (cos ϕ), root mean square (RMS), SI prefixes (milli, micro, nano).
- Definition of current in terms of rate of flow of mobile charge carriers, electron flow versus conventional current, and current density concept (qualitative).
- Definition of electromotive force (EMF) as measure of ratio of energy supplied per unit charge/open-circuit source voltage.
- Definition of conductance and resistance in relation to density of mobile charge carriers, temperature dependence of resistance (metals vs semiconductors), and NTC/PTC behaviour.

A2 Electrical formulae and relationships

- Energy supplied $W = Vit$.
- Capacitor energy $E=½CV^2$.
- Inductor energy $E = ½LI^2$.
- Use of Ohm's Law $V = IR$.
- Small-signal resistance of non-ohmic devices (qualitative).
- Kirchhoff's Laws – KCL & KVL with simple node/mesh examples.
- Power P = IV, P = I2R, $P=V^2/R$, apparent power S = VI, real power P_VI cos ϕ.
- Charge $Q = It$.
- Conductance

$$G = \frac{1}{R} = \frac{L}{V}$$

- Conductivity σ where

$$\mathrm{R} = \frac{\rho \mathrm{L}}{\mathrm{A}}$$

- Resistivity

$$R = \frac{\rho l}{A}$$

- Capacitors:
  - charge stored by capacitors Q = CV in operation as a reservoir
  - capacitors in smoothing (rectifiers), decoupling, filters, timing, supercapacitors overview
  - charging and discharging graph representations, time constant τ =RC, v(t) qualitative forms, log scale use on plots
  - calculations of capacitances ($C_T = C_1 + C_2$ for parallel capacitors, $\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2}$ for series capacitors)
  - voltage rating selection and equivalent series resistance (ESR) concept.

A3 Electrical properties and uses of materials

- Conductivity and resistivity, e.g. thermal effects, alloys (nichrome, constantan), materials selection for sensors:
  - insulators and conductors, e.g. dielectrics, dielectric strength
  - ohmic and non-ohmic conductors, e.g. lamp filament, diodes, varistors (MOV) for surge suppression
  - capacitors as a filter in AC circuits, e.g. inductors and LC filters, EMI/EMC basics, switch-mode power supplies (SMPS)
  - semiconductors, e.g. LED technology (efficiency), photovoltaics.

Learning aim B: Construct series and parallel circuits for use in standard electrical applications

B1 Circuit characteristics

- Correct assembly of series and parallel resistive circuits using up to three resistors in series, parallel and series-parallel combination, e.g. LED with current-limiting resistor.
- Calculation of resistance and conductance ($R_T = R_1 + R_2$ for series circuits $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ for parallel circuits and similarly for conductance), data analysis, e.g. measuring error, plotting results.
- Tolerance and temperature coefficient effects, equivalent resistance reduction strategies.

B2 Measurement devices

- Use of ammeters and voltmeters (digital and analogue types for simple comparison):
  - nature of voltage drop across components as the energy dissipates per unit charge by a resistor (where the energy dissipated is transferred from electricity into heat)
  - potential divider circuits and potential divider calculation
  - internal resistance and EMF with use of $E = I(R + r)$
  - battery internal resistance measurement
  - state-of-charge (qualitative), USB-C power delivery for low-voltage DC supply.

Learning aim C: Examine AC and DC production and safe working with electricity

[MY – TPR]

C1 DC production

- Battery (dry cell) construction (zinc, zinc chloride/ammonium chloride and carbon/manganese dioxide), e.g. alkaline, Li-ion.
- Passage of electrons as unidirectional.
- DC produced by thermocouples and solar cells, e.g. rectification of AC to DC (bridge rectifier + smoothing).

C2 AC production, three-phase systems and transmission

- Magnetic fields around permanent magnets and a wire carrying a current, applications, e.g. electromagnets, relays, solenoids.
- Fleming’s left-hand rule.
- Fleming’s right-hand rule.
- Electromagnetic induction and Faraday’s law, concept of practical alternator.
- Principles of Lenz’s law.
- Transformer principles and equations (step-up and step-down), core materials, efficiency.
- Power loss from cables (I2R).

C3 Domestic applications and mains supply

- Root mean square (RMS) use as a measure.
- Domestic ring main circuit, smart meters, smart home loads, e.g. LED drivers, heat pumps.
- Nature of AC voltage as changing polarity with instantaneous values varying sinusoidally, frequency (50Hz), RMS vs peak relations.
- Peak and peak-to-peak voltages.
- Domestic fuse ratings, fuses and MCB ratings.
- Earthing systems.
- Fuses.

- Significance of double insulation, Ingress Protection (IP) ratings.
- Residual current and circuit breakers (RCCB), Arc Fault Detection Device (AFDD), Surge Protective Device (SPD).

C4 Safety, human physiology and electricity

- Typical resistance values for current pathways in the human body.
- Human skin resistance and changes of environment, e.g. moisture levels of the skin, contact with the ground.
- Heart responses to electric shock.
- Principles of the defibrillator, Automated External Defibrillator (AED) in workplaces and community.
- Effect of the length of current exposure time and amount of electrical current, arc flash hazard awareness.
- Safe levels of DC voltage.
- Laws and regulations (electricity at work, wiring, provision and use of work equipment).
- Safe systems, Lockout/Tagout (LOTO), permits to work, personal protective equipment (PPE), risk assessment, 'test-before-touch'.

Learning aim D: Examine the uses of transducers, sensors and other measurement devices

D1 Uses of passive transducers

- As defined by devices that change the electrical characteristics within a circuit by the influence of external physical factors (sensors) – e.g. light-dependent resistor (LDR) and their practical uses; thermistors; strain gauge and Wheatstone bridge arrangement; potential divider circuits; resistance temperature detectors (RTDs); Hall-effect sensors (magnetic); potentiometric position sensors; force-sensitive resistors (FSRs).
- Uses of light meters, automatic cameras, alarm systems, building automation (lighting, HVAC), Internet of Things (IoT) devices, wearables.

D2 Uses of active transducers

- Production of EMF by conversion of energy from external physical source, e.g. operation and structure of a thermocouple – measurement sources (small EMF).
- Piezoelectric devices and fundamental principles, e.g. vibration/knock sensing.
- Understanding of the need for signal amplification for these devices, e.g. basic signal conditioning (instrumentation amplifier, low-pass filter).
- Photovoltaic cells (as active transducers), energy harvesting (vibration, thermal, light) for low-power sensors.

D3 Sensors, instrumentation and data systems

- Oscilloscopes for voltage measurement and AC/DC display, digital storage oscilloscopes (DSO) probe safety.
- Multimeter and range of measurements.
- Data-logging devices, such as those that sense and store information.

Assessment criteria

Learning aim A: Understand electrical symbols, SI units, definitions, relationships and properties of circuit components

Learning aim B: Construct series and parallel circuits for use in standard electrical applications

Pass	Merit	Distinction
A.P1 Explain principal electrical terms, quantities and relationships for given situations.	**A.M1** Use, with calculations, principal electrical terms, quantities and relationships for given situations.	**AB.D1** Evaluate, by calculation and graphical representation, the operation of circuit assemblies using measured values.
B.P2 Accurately construct and record circuits and values.	**B.M2** Compare predicted and calculated fundamental electrical values for circuit assemblies.	

Learning aim C: Examine AC and DC production and safe working with electricity

Pass	Merit	Distinction
C.P3 Explain similarities and differences of AC and DC electrical circuits. **C.P4** Explain dangers of working with electricity and its effects on human physiology.	**C.M3** Compare RMS and peak values of AC electricity. **C.M4** Discuss procedures and practices used to minimise risk when working with electricity.	**C.D2** Evaluate the principles of AC production and transmission for safe use in suitable applications.

Learning aim D: Examine the uses of transducers, sensors and other measurement devices

Pass	Merit	Distinction
D.P5 Explain basic principles of operation of transducers, sensors and electrical measurement.	**D.M5** Demonstrate the correct basic principles and uses of transducers, sensors and electrical measurement devices.	**D.D3** Evaluate the uses and fitness for purpose of transducers, sensors and measurement devices.

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 a part of wider teaching and learning

√ Embedded in teaching, learning and assessment

blank Not embedded or signposted in unit

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. The *Pearson BTEC International Level 3 Qualifications Supplementary Information* document gives information on setting assignments. There is also further information on our website.

There is a maximum number of 3 summative assignments for this unit.

The relationship of the learning aims and criteria is:

Learning aims: A and B (A.P1, B.P2, A.M1, B.M2, AB.D1)

Learning aim: C (C.P3, C.P4, C.M3, C.M4, C.D2)

Learning aim: D (D.P5, D.M5, D.D3)

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- Circuit kits with resistors, capacitors, switches, LEDs, batteries and breadboards for hands-on assembly and testing.
- Multimeters and oscilloscopes for measuring voltage, current, resistance and waveform analysis.
- Visual aids: electrical symbols charts, SI units reference posters and circuit diagrams for classroom display.
- Access to simulation software (e.g. Multisim, Tinkercad) for virtual circuit design, analysis and troubleshooting.

Essential information for assessment decisions

Learning aims A and B

For distinction standard, students provide insightful evaluations of circuit assemblies by integrating calculations, graphical representations and measured values. Evidence is shown using experimental data to critically assess circuit operation, examining discrepancies between theoretical predictions and actual measurements. The student demonstrates advanced understanding by interpreting complex relationships, such as the impact of non-ohmic behaviour, component tolerances and environmental factors on circuit performance. Their work synthesises information from multiple sources, including graphical plots and calculated results, to draw well-supported conclusions about the suitability and effectiveness of circuit designs. The student's evaluation is thorough and reflects a high level of analytical skill, demonstrating the ability to communicate findings clearly and to assess the fitness of circuits for specific applications.

For merit standard, students confidently apply electrical concepts, using calculations to analyse circuit behaviour and solve problems involving electrical quantities. Evidence includes accurate use of formulae to predict outcomes, such as calculating energy supplied or resistance in various configurations, and validating these predictions through practical measurement. The student interprets data and applies relationships between electrical terms to assess circuit performance, demonstrating proficiency in both theoretical analysis and hands-on construction. Their work shows a systematic comparison of predicted and measured values, with explanations for any discrepancies. The student also demonstrates awareness of factors such as temperature effects and material selection in circuit design. Their approach is analytical and well-justified, consistently using evidence from calculations and practical activities to support their conclusions about circuit operation and design.

For pass standard, students demonstrate a foundational understanding of electrical principles by accurately identifying and explaining key symbols, SI units and definitions relevant to circuit components. Evidence is shown through clear explanations of how electrical quantities relate to practical scenarios, such as describing current flow and the role of resistance. The student applies these concepts when assembling series and parallel circuits, ensuring correct placement of components and precise documentation of measured values. Their work reflects attention to detail in both theoretical and practical aspects, including the recording of voltage and current for each configuration. The student's approach is methodical, consistently producing circuits that function as intended and showing awareness of safety and basic circuit construction principles. Overall, the student's responses indicate a sound grasp of fundamental electrical concepts and the ability to apply them in practical circuit assembly.

Learning aim C

For distinction standard, students evaluate the principles of AC production and transmission, providing comprehensive analysis of safe use in suitable applications. Evidence includes critical examination of power generation and distribution systems, with the student assessing the effectiveness of safety measures and the impact of technological advancements. Their work demonstrates advanced understanding by interpreting complex relationships, such as the role of transformers and power factor correction in efficient transmission. The student synthesises information from multiple sources to draw well-supported conclusions about the suitability of AC systems for different environments, reflecting a high level of analytical skill.

For merit standard, students compare RMS and peak values of AC electricity, demonstrating proficiency in interpreting electrical measurements. Evidence is shown through accurate calculations and explanations of how these values relate to practical applications, such as domestic power systems. The student discusses procedures and practices used to minimise risk when working with electricity, referencing relevant regulations and safety protocols. Their work reflects a systematic approach to risk assessment and the implementation of safe working practices, showing a clear understanding of the importance of electrical safety.

For pass standard, students explain the similarities and differences between AC and DC circuits, providing clear descriptions of their characteristics and applications. Evidence includes accurate accounts of how each type of circuit operates, referencing practical examples such as battery-powered devices and mains electricity. The student demonstrates understanding of the dangers associated with electricity, discussing its effects on human physiology and the importance of safety measures. Their work reflects awareness of key safety principles and the need to carefully handle electrical equipment in various environments.

Learning aim D

For distinction standard, students evaluate the uses and fitness for purpose of transducers, sensors and measurement devices, providing comprehensive analysis of their suitability for specific applications. Evidence includes critical examination of device performance, with the student assessing factors such as accuracy, reliability and environmental influences. Their work demonstrates advanced understanding by synthesising information from multiple sources, including experimental data and theoretical analysis, to draw well-supported conclusions about the effectiveness of different devices. The student's evaluation is thorough and reflects a high level of analytical skill and judgement.

For merit standard, students demonstrate correct use of transducers, sensors and electrical measurement devices, applying principles to practical scenarios. Evidence is shown through accurate selection and operation of devices in experimental activities, with the student interpreting results and explaining their significance. Their work reflects proficiency in using instrumentation to monitor and analyse electrical systems, showing awareness of the factors that influence device performance. The student's approach is systematic, and they consistently justify their choices with reference to theoretical principles and practical requirements.

For pass standard, students explain the basic principles of operation for transducers, sensors and electrical measurement devices, providing clear descriptions of their functions and uses. Evidence includes accurate accounts of how different devices respond to physical stimuli and convert these into electrical signals. The student demonstrates understanding of the role of measurement devices in monitoring and controlling electrical systems, referencing practical examples such as temperature sensors and oscilloscopes. Their work reflects a sound grasp of fundamental concepts and the ability to communicate these effectively.

Links to other units

The assessment for this unit will draw upon some of the underpinning knowledge, understanding and skills covered in:

- Unit 3: Principles and Applications of Physics
- Unit 8: Physics for Energy, Materials and Communication
- Unit 9: Practical Scientific Procedures and Techniques.

Unit 13: Human Disease, Infection and Environmental Health

Level: 3

Unit type: Internal

Guided learning hours: 60

Unit in brief

Students research the types, transmission and prevention of diseases, alongside the impact of environmental pollution on health. The unit also explores how the human body defends itself against infections.

Unit introduction

This unit links directly to real-world health and wellbeing by developing essential understanding of diseases, infections and environmental health risks. These issues affect individuals, communities and global populations. Students learn how diseases spread, how public health is protected and why environmental responsibility matters, preparing them to make informed decisions and contribute positively to society.

In this unit, you will study the characteristics and progression of infectious, dietary, genetic and degenerative diseases. You will examine transmission pathways, prevention strategies and the role of global organisations in disease control. The unit also explores environmental pollution, its health impacts, ways to reduce pollution, and the body's defence mechanisms, including specific and non-specific immune responses.

Completing this unit develops analytical and evaluative skills valuable for further study in health, science or environmental disciplines. The knowledge gained supports progression into higher education or employment in healthcare, public health, laboratory science and environmental management. Students become better prepared to understand current health challenges and contribute effectively to solutions in professional settings.

Learning aims

In this unit, you will:

A Understand different types of human diseases and their impact on health

B Examine the transmission of infectious diseases and how we can prevent their spread

C Investigate causes and effects of environmental pollution and the impact on public health

D Understand how the human body responds to infections and how this keeps us healthy.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Understand different types of human diseases and their impact on health	**A1** Pathogens and infectious diseases **A2** Dietary and lifestyle diseases **A3** Genetic and degenerative disease **A4** Impact of diseases over time	Case studies of causes and effects of diseases on human body systems.
B Examine the transmission of infectious diseases and how we can prevent their spread	**B1** Methods by which infectious diseases can be spread **B2** Methods by which infectious diseases can be prevented from spreading **B3** Management of infectious diseases	Report on the role of organisations in limiting the spread of infectious diseases and environmental pollution.
C Investigate causes and effects of environmental pollution and the impact on public health	**C1** Water pollution **C2** Air pollution **C3** Radioactivity **C4** Methods of reducing pollution and the associated benefits on short and long-term public health	
D Understand how the human body responds to infections and how this keeps us healthy	**D1** Defence mechanisms **D2** Non-specific **D3** Specific	Information sheets comparing the components of two defence mechanisms and their mode of action.

Content

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

Learning aim A: Understand different types of human diseases and their impact on health

A1 Pathogens and infectious diseases

- Pathogens – types and characteristics, life cycle and actions:
  - bacteria: prokaryotic, unicellular, rapid replication/reproduction, damage to cells, toxin release damage to cells
  - parasites: eukaryotic, unicellular or multicellular, require host, endoparasite or ectoparasite
  - fungus: eukaryotic, ectoparasitic, opportunistic pathogen
  - protozoa: eukaryotic, unicellular, toxin release damages cells or causes mechanical damage'
  - viruses: acellular, DNA/RNA genome in a protein coat, obligate parasites, take over host cell metabolism and cause cell death
  - prions: misfolded proteins that trigger other normal proteins to misfold.
- Infectious diseases:
  - pathogenic organisms invading the body: COVID-19, HIV, malaria, gonorrhoea, Ebola, tuberculosis
  - zoonotic (between animals and humans): Mpox, Zika virus, ringworm, tapeworm, rabies, avian flu H5N1, ticks and Lyme disease, mites
  - zoonotic spillover due to:
    - climate changes, e.g. dengue, Lyme disease
    - habitat destruction, e.g. Nipah virus
    - intensive agriculture, e.g. avian flu, Salmonella
  - antibiotic-resistant infections (e.g. MRSA, CRE).

A2 Dietary and lifestyle diseases

- Dietary and lifestyle:
  - dietary deficiency, e.g. proteins and kwashiorkor, vitamin C and scurvy, iron and anaemia
  - dietary excess
    - cardiovascular disease (high fat, cholesterol, salt)
    - obesity (excess calories, sedentary lifestyle)
    - type 2 diabetes (high-fat, high-carbohydrate diets)
  - impacts of ultra-processed foods (salts, sugars, trans fats)
  - liver disease (high-fat diet, alcohol).

A3 Genetic and degenerative disease

- Genetic – inherited through DNA:
  - patterns of inheritance
    - autosomal dominant (e.g. Huntington’s disease)
    - autosomal recessive (e.g. cystic fibrosis)
    - co-dominance (e.g. sickle cell anaemia)
    - sex-linked disorders (e.g. haemophilia)
  - Punnett square
  - mutation of DNA sequence
  - epigenetics
  - gene editing (CRISPR).
- Multi-gene interacting diseases are often degenerative and can lead to decline in function, e.g. Alzheimer’s, osteoporosis, osteoarthritis, Parkinson’s disease.

A4 Impact of diseases over time

- Latency and incubation period.
- Asymptomatic, pre-symptomatic and symptomatic.
- Long COVID.
- Chronic fatigue syndrome.
- Effect on ability to lead a normal life/work.
- Digital health monitoring.

Learning aim B: Examine the transmission of infectious diseases and how we can prevent their spread

B1 Methods by which infectious diseases can be spread

- Direct contact – transmission:
  - human to human, body fluids
  - animal to human, animal waste (droppings).
- Indirect contact:
  - climate change impact on vector distribution – fleas, lice, ticks, mosquitoes
  - transmission – surfaces, airborne transmission via aerosols
  - contamination – food or water, e.g. Salmonella, typhoid.
- Digital contact tracing.

B2 Methods by which infectious diseases can be prevented from spreading

- Prophylaxis:
  - antibiotics
  - antimalarial
  - antiviral.

- Personal protective equipment (PPE):
  - gloves
  - face masks
  - biohazard suits.
- Behaviours:
  - safe sex
  - mosquito nets
  - hand washing.
- Vaccination to prevent spread of disease:
  - vaccination programmes
  - types of vaccine (modified, attenuated, live antigens, mRNA vaccines)
  - specificity to pathogen
  - stimulation of antibody production
  - herd immunity.
- Isolation/quarantine.
- Use of AI in outbreak prediction.

B3 Management of infectious diseases

- Aims and key roles of national and global organisations:
  - World Health Organization (WHO)
  - Médecins sans Frontières (MSF)
  - Oxfam
  - UNICEF
  - WaterAid.
- Centers for Disease Control and Prevention (CDC).
- Digital health platforms, data-sharing initiatives.

Learning aim C: Investigate causes and effects of environmental pollution and the impact on public health

C1 Water pollution

- Agricultural (pesticides and fertilisers, nitrates and phosphates, animal waste).
- Domestic (microplastics, per- and polyfluoroalkyl substances (PFAS) – 'forever chemicals').
- Industrial (chemical and oil accidents).
- Bacterial contamination from Illegal discharge of effluent (e.g. cholera).

C2 Air pollution

- Industry – use of fossil fuels; sulphur dioxide, volatile organic compounds (VOCs).
- Transport – carbon monoxide, nitrogen oxides, diesel particulate matter.
- Agriculture – methane from livestock, burning of agricultural waste.
- Natural sources – asbestos, smog, volcanic eruptions, sand and dust storms.
- Indoor air pollution.
- Wildfire smoke.

C3 Radioactivity

- Nuclear accidents, power plants, chemical spillage.
- Nuclear fuel, extraction, power plants, nuclear waste.
- Nuclear weapons.
- Radiation – ultraviolet (UV): skin cancer.
- Radioactive isotopes.
- Background radiation.

C4 Methods of reducing pollution and the associated benefits on short- and long-term public health

- Incentives to reduce, reuse, recycle.
- Reduction of use of pesticides and fertilisers, reduction of use of fossil fuels.
- Carbon capture, gas scrubbers, catalytic converters.
- Alternative forms of transport and energy sources.
- Global organisations, initiatives and potential solutions to reduce pollution and its effects, e.g. WHO, climate action frameworks, MSF, Oxfam, UNICEF, WaterAid.

Learning aim D: Understand how the human body responds to infections and how this keeps us healthy

D1 Defence mechanisms

- Non-specific or innate response: immediate response; physical barrier, phagocytosis.
- Specific: slower response, specific to pathogen; cell-mediated response (T-lymphocytes), humoral response (B-lymphocytes).
- Also known as adaptive immunity.

D2 Non-specific

- Physical barrier, e.g. skin, nasal hairs.
- Chemical barriers, e.g. mucus, stomach acid – hydrochloric acid (HCl), tear duct secretions (lysozyme), sebum.
- Role of microbiota.
- Skin microbiome.

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

- Gut microbiome.
- Process of phagocytosis: phagocyte, role of histamine, lysosomes, lysozyme.

D3 Specific

- Differentiate between cell-mediated and humoral response (lymphocyte type, location of lymphocyte development and maturation, what it acts against):
  - cell-mediated response; response to invasion of non-self-material, e.g. cells infected with a virus, T-lymphocytes action (helper, cytotoxic), role of antigens, produced in bone marrow but matured in thymus
  - humoral response; B-lymphocytes action against free pathogens, plasma cells, memory cells, role of antibodies, role of antigens, secondary immune response, interaction with T-cells, produced and matured in the bone marrow.
- Immune memory in COVID-19.
- Autoimmune diseases (e.g. type 1 diabetes, lupus).
- Immune dysregulation (allergies, HIV/AIDS).
- Immunotherapy (monoclonal antibodies, vaccination, allergen desensitisation).

Assessment criteria

Learning aim A: Understand different types of human diseases and their impact on health

Pass	Merit	Distinction
A.P1 Describe the characteristics of the six main types of pathogens and a disease caused by each. **A.P2** Explain causes of non-infectious diseases in humans.	**A.M1** Compare effects of a named infectious and non-infectious disease on human body systems.	**A.D1** Analyse how an infectious and non-infectious disease may progress over time, and the effects this may have on affected individuals.

Learning aim B: Examine the transmission of infectious diseases and how we can prevent their spread

Learning aim C: Investigate causes and effects of environmental pollution and the impact on public health

Pass	Merit	Distinction
B.P3 Explain how three infectious diseases can be transmitted. **B.P4** Describe ways infectious diseases can be prevented from spreading.	**B.M2** Assess how infectious diseases can be prevented from spreading.	**BC.D2** Evaluate the role of organisations in limiting the spread of infectious diseases and environmental pollution.
C.P5 Describe causes of three environmental pollutants and their effects on public health. **C.P6** Outline ways to reduce environmental pollution.	**C.M3** Analyse methods used to reduce the effects of environmental pollutants.	

Learning aim D: Understand how the human body responds to infections and how this keeps us healthy

Pass	Merit	Distinction
D.P7 Outline how knowledge of the immune system can be used in medicine. **D.P8** Explain components of specific and non-specific defences for protecting the human body.	**D.M4** Compare the roles of specific and non-specific defence mechanisms in the human body.	**D.D3** Evaluate the roles of cell-mediated and humoral responses to pathogens.

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 a part of wider teaching and learning
√	Embedded in teaching, learning and assessment
blank	Not embedded or signposted in unit

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments. There is also further information on our website.

There is a maximum number of 3 summative assignments for this unit.

The relationship of the learning aims and criteria is:

Learning aims: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, B.M2, C.M3, BC.D2)

Learning aim D: (D.P7, D.P8, D.M5, D.D3)

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- Up-to-date textbooks and digital resources covering human diseases, infections and environmental health.
- Access to case studies, scientific articles and real-world data on disease transmission and pollution.

Essential information for assessment decisions

Learning aim A

For distinction standard, an analytical account examines how an infectious disease, such as HIV, and a non-infectious disease, like Alzheimer's, progress over time. The evidence discusses latency, incubation and chronic phases, considering how HIV may remain asymptomatic before immune decline, while Alzheimer's leads to gradual cognitive deterioration. The impact on daily life, work and wellbeing is evaluated, showing how disease progression affects individuals physically, mentally and socially.

For merit standard, students analyse the effects of an infectious disease, such as malaria, and a non-infectious disease, like type 2 diabetes, on human body systems. The discussion considers how malaria disrupts red blood cells and causes fever, while diabetes affects glucose regulation and can damage nerves and blood vessels. The evidence shows thoughtful comparison of symptoms, progression and long-term health consequences for each disease.

For pass standard, students describe the main features of six pathogen types, such as bacteria, viruses, fungi, protozoa, parasites and prions, alongside a disease caused by each. For example, the explanation highlights how bacteria reproduce rapidly and release toxins, causing tuberculosis, while viruses hijack host cells, leading to COVID-19. The response also explains how non-infectious diseases arise, such as dietary deficiencies resulting in anaemia or genetic mutations causing cystic fibrosis. The evidence demonstrates understanding of disease mechanisms and their impact on health.

Learning aims B and C

For distinction standard, students produce in in-depth evaluation of how infectious diseases are controlled and how pollution affects public health. Evidence includes discussion of the role and effectiveness of global organisations such as the World Health Organization and Médecins Sans Frontières in managing disease outbreaks, coordinating global responses and supporting data-sharing platforms. Students also evaluate the broader health impacts of pollution, considering long-term risks, policy measures and organisational interventions that reduce harm. Their work demonstrates advanced evaluative skills through synthesising complex information, assessing societal and environmental implications, and proposing well-reasoned recommendations for improving both disease control and environmental health.

For merit standard, students analyse how infectious diseases can be prevented from spreading, considering the effectiveness of vaccination programmes, quarantine, and behavioural interventions such as safe sex practices and mosquito-net use. They also examine approaches to reducing environmental pollution, evaluating the impact of strategies such as recycling, alternative energy use and regulatory controls. Evidence demonstrates the ability to weigh different perspectives, use real-world examples, and show how interventions and pollution-reduction strategies influence public health decisions, sustainability and long-term outcomes.

For pass standard, students detail how at least three infectious diseases are transmitted – such as airborne spread of COVID-19, vector transmission of malaria and food- or water-borne transmission of Salmonella. They outline practical ways to prevent infection, including handwashing, vaccination and PPE use. Students also describe the origins and consequences of three environmental diseases, linking pollution sources to health effects on individuals and communities. Evidence includes sufficiently supported explanations and references ways to reduce air and water pollution, showing understanding of key transmission routes, health impacts and basic prevention strategies.

Learning aim D

For distinction standard, students evaluate cell-mediated and humoral immune responses, discussing their roles in combating pathogens. Evidence includes analyses of immune processes, memory formation and implications for disease resistance, with reference to current scientific understanding.

For merit standard, students compare the functions of specific and non-specific defences, highlighting differences in response and effectiveness. Their work demonstrates the ability to relate immune mechanisms to disease prevention, supported by examples of how each system operates.

For pass standard, students explain the main components of the body's defence systems, distinguishing between specific and non-specific mechanisms. Evidence includes accurate descriptions of physical, chemical and immune responses, showing a basic understanding of protection against pathogens.

Links to other units

The assessment for this unit will draw upon some of the underpinning knowledge, understanding and skills covered in:

- Unit 1: Principles and Applications of Biology
- Unit 6: Health Challenges and Medical Innovations
- Unit 9: Practical Scientific Procedures and Techniques
- Unit 16: Human Body Systems: Physiology, Disorders and Health Solutions
- Unit 20: Human Body Systems: Regulation, Control and Reproduction.

Unit 14: Biochemical Processes and Pathways in Living Organisms

Level: 3

Unit type: Internal

Guided learning hours: 60

Unit in brief

Students study the structure and function of biological molecules, respiration in humans, and photosynthesis in plants. The unit develops practical, analytical and evaluative skills for scientific progression.

Unit introduction

This unit develops understanding of biological molecules, respiration and photosynthesis – core processes vital to life, health and industry. Learning these concepts helps students understand how organisms function and respond to environmental change, supporting careers in healthcare, biotechnology, agriculture and environmental science.

You will explore the structure and functions of major biological molecules and the biochemical reactions that sustain life, including factors that may disrupt them. The unit covers human respiration, examining the effects of exercise and harmful substances, and investigates photosynthesis pathways and limiting factors. Practical experiments, data interpretation and case studies strengthen both theoretical knowledge and applied laboratory skills.

Completing this unit provides a solid foundation for further study in biology, biochemistry and related fields. Students develop analytical, practical and evaluative abilities valued in higher education and employment, including research, laboratory work, healthcare and environmental management. The unit also builds scientific literacy and problem-solving skills essential for modern scientific careers.

Learning aims

In this unit, you will:

A Understand the structure and function of biological molecules and their importance in maintaining biochemical processes

B Explore the effect of activity on respiration in humans and factors that can affect respiratory pathways

C Explore the factors that can affect the pathways and the rate of photosynthesis in plants.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Understand the structure and function of biological molecules and their importance in maintaining biochemical processes	**A1** Water **A2** Carbohydrates **A3** Proteins and nucleic acids **A4** Lipids **A5** Disruption of biochemical processes in living organisms	Presentation or report on molecular structure and its role in the human body.
B Explore the effect of activity on respiration in humans and factors that can affect respiratory pathways	**B1** Respiration **B2** Effect of activity on requirements for oxygen and output of CO_2 **B3** Factors that can affect respiration	Presentation or report on practical work carried out and outcomes.
C Explore the factors that can affect the pathways and the rate of photosynthesis in plants	**C1** Pathways in photosynthesis **C2** Factors that can affect the pathways in photosynthesis	Presentation or report on practical work carried out and outcomes.

Content

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

Learning aim A: Understand the structure and function of biological molecules and their importance in maintaining biochemical processes

A1 Water

- Structure and features, to include:
  - contains hydrogen (H) and oxygen (O) atoms
  - structural and chemical formulae of water.
- Bonding, to include:
  - covalent bonding (in water molecule)
  - hydrogen bonding (between water molecules).
- Importance of water, to include:
  - as a solvent
  - medium for chemical reactions
  - pH regulation
  - electrolyte balance
  - temperature regulator
  - cohesion-tension in transpiration
  - innovative role of water in different areas, e.g. cell signalling, nanobiotechnology, biomolecular interactions in synthetic biology.

A2 Carbohydrates

- Structure and features, to include:
  - contains carbon (C), hydrogen (H), and oxygen (O) atoms
  - monosaccharides, e.g. α and β glucose, galactose, fructose, ribose and deoxyribose
  - disaccharides, e.g. lactose, maltose and sucrose
  - polysaccharides, e.g. amylose, amylopectin, cellulose
  - tests for the presence of carbohydrates, to include:
    - iodine solution for starch
    - Benedict's solution for reducing sugars
- Importance of carbohydrates, to include:
  - energy production
  - energy storage
  - structural/building

  - role in lipid metabolism
  - prevention of protein breakdown for energy in animals.
- Innovative application of carbohydrates in different research areas:
  - e.g. biosensors and chromatographic techniques to detect and analyse carbohydrates.

A3 Proteins and nucleic acids

Structure and features, to include:

- Proteins:
  - 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, disulphide (sulphur) bridges and van der Waals forces
  - quaternary structure, e.g. haemoglobin
  - classification as globular or fibrous
  - test for presence of protein, to include Biuret solution
  - nucleic acids: nucleotide structure (deoxyribose or ribose sugar, phosphate group, and purine or pyrimidine base)
  - polynucleotide structure with phosphodiester bonds made through condensation reactions
  - DNA double helix formed by complementary base pairing.
- Importance of proteins and nucleic acids, to include:
  - enzymes that control metabolism
  - as neurotransmitters antibodies
  - hormones
  - for transport of other components
  - body tissue growth and repair
  - muscle contraction in animals (actin and myosin interaction: detailed knowledge of the sliding filament theory not required)
  - blood clotting in animals
  - nucleic acid test
  - role of nucleic acids in coding for genes and controlling gene expression
  - innovative application of proteins in different research areas, such as:
    - synthetic biology
    - CRISPR-Cas9 gene editing
    - biopharmaceuticals

Issue 1 – March 2026 © Pearson Education Limited 2026

A4 Lipids

- Structure and features, to include:
  - contains carbon (C), hydrogen (H) and oxygen (O) atoms, e.g. in fats, oils and waxes
  - saturated and unsaturated fats
  - formation of diglycerides and triglycerides through esterification reactions
  - test the presence of lipids using emulsion tests.
- Importance of lipids to include:
  - energy sources
  - insulation and organ protection in animals
  - phospholipids in membranes
  - production of vitamins
  - innovative application of lipids in different research areas, such as:
    - cell signalling
    - lipidomics
    - targeted drug delivery systems

A5 Disruption of biochemical processes in living organisms

- The physiological and psychological causes and effects of disruption to biochemical processes, to include:
  - lactose intolerance
  - diabetes mellitus
  - cystic fibrosis
  - neurotransmitter imbalances
  - interference in plant growth regulators, e.g. delaying or promoting fruit ripening using the effects of ethene and gibberellins
  - disruption of auxin transport
  - substance-induced disruption
  - use of synthetic auxin
  - other conditions, such as:
    - epigenetic disorders
    - autoimmune diseases
  - impact of microplastics and nanoparticles on biochemical pathways.

Learning aim B: Explore the effect of activity on respiration in humans and factors that can affect respiratory pathways [MY – TPR]

B1 Respiration

- Adenosine triphosphate (ATP) as the universal energy currency.
- Stages and locations of aerobic and anaerobic respiratory pathways.

- Glycolysis: conversion of monosaccharides to pyruvate; production of lactic acid in anaerobic respiration and ethanol in yeast.
- Link reaction.
- Different roles, e.g. mitochondrial dysfunction in ageing and disease, bioenergetics in cancer cells and real-time metabolic imaging.
- Krebs cycle:
  - conversion of molecules in the cycle from citric acid to oxaloacetate
  - carbon dioxide (CO_2) production.
- Electron transport chain in ATP production:
  - reduction of coenzymes
  - cytochrome system and ATP synthase
  - importance of oxygen as final electron acceptor and nicotinamide adenine dinucleotide (NAD) as hydrogen acceptor.

B2 Effect of activity on requirements for oxygen and output of CO_2

- Recovery rates after exercise, as measured by breathing rate.
- Short-term anaerobic respiration leading to oxygen debt.
- Effect of exercise on carbon dioxide output; potential damaging effects of excess CO_2 and lactic acid; bicarbonate buffering system of blood.
- Use of wearable biosensors and AI to monitor respiration.

B3 Factors that can affect respiration

The causes and effects of the following on the ability of individuals to carry out processes leading to efficient respiration:

- Cigarettes:
  - inhalation of toxins
  - tar
  - nicotine
  - e-cigarettes.
- Drugs:
  - ketamine
  - cocaine interferes with how the brain processes chemicals.
- Pollutants:
  - asbestos
  - oxidants causing inflammation and metabolic damage to the cells
  - airborne microplastics
  - urban air quality monitoring.
- Disease, e.g. asthma.

Learning aim C: Explore the factors that can affect the pathways and the rate of photosynthesis in plants

C1 Pathways in photosynthesis

- Light-dependent reaction:
  - stages in and location of photophosphorylation, including role of coenzymes and photolysis
  - light energy converted to chemical energy held in ATP.
- Light-independent reaction:
  - stages in and location of the Calvin cycle
  - role of ribulose bisphosphate (RuBP) and ribulose bisphosphate carboxylase (RuBisCO)
  - production of glucose.
- Innovative roles, e.g. artificial photosynthesis, genetic engineering of photosynthetic efficiency, biohybrid systems.

C2 Factors that can affect the pathways in photosynthesis

- Requirements for photosynthetic organisms, including sources and control of limiting factors, e.g. light intensity, CO_2 concentration, temperature, water.
- Role of photosynthetic pigments (chlorophylls and carotenoids) in absorbing different wavelengths of light:
  - Innovative roles, e.g. climate change impacts, vertical farming, LED light optimisation, and carbon-capture technologies.

Assessment criteria

Learning aim A: Understand the structure and function of biological molecules and their importance in maintaining biochemical processes

Pass	Merit	Distinction
A.P1 Explain the structure of biological molecules in living organisms. **A.P2** Describe uses of carbohydrates in real-world applications.	**A.M1** Explain the links between the structure and function of biological molecules and their role in living organisms. **A.M2** Explain uses of carbohydrates in real-world applications.	**A.D1** Evaluate the effects of disruption of biochemical processes in living organisms.

Learning aim B: Explore the effect of activity on respiration in humans and factors that can affect respiratory pathways

Pass	Merit	Distinction
B.P3 Explain the stages involved in the human respiratory pathway. **B.P4** Describe factors that can affect respiration. **B.P5** Describe effects of activity on respiration in humans.	**B.M3** Analyse primary and secondary data to explain the effect of activity on respiration. **B.M4** Explain the harmful effects of factors on human respiration.	**B.D2** Evaluate the effects of harmful substances on the efficiency of human respiration.

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

Learning aim C: Explore the factors that can affect the pathways and the rate of photosynthesis in plants

Pass	Merit	Distinction
C.P6 Explain the stages involved in photosynthesis in plants. **C.P7** Investigate factors that affect the rate of photosynthesis.	**C.M5** Analyse primary and secondary data to explain factors that affect the rate of photosynthesis.	**C.D3** Evaluate the effect of factors on photosynthetic efficiency.

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 a part of wider teaching and learning
√	Embedded in teaching, learning and assessment
blank	Not embedded or signposted in unit

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments. There is also further information on our website.

There is a maximum number of 3 summative assignments for this unit.

The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.M2, A.D1)

Learning aim: B (B.P3, B.P4, B.P5, B.M3, B.M4, B.D2)

Learning aim: C (C.P6, C.P7, C.M5, C.D3)

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- Molecular model kits, diagrams, and digital simulations for visualising biological molecule structures and biochemical processes.
- Laboratory equipment and reagents for practical tests (e.g. Benedict's, Biuret, emulsion tests) and respiration/photosynthesis experiments.
- Data sets, case studies and wearable biosensors for analysing respiration, photosynthesis and effects of activity or environmental factors.
- Access to scientific literature, multimedia resources and interactive platforms for exploring innovative applications and disruptions in biochemical pathways.

Essential information for assessment decisions

Learning aim A

For distinction standard, students critically assess the impact of disruptions to biochemical processes, drawing on examples such as genetic disorders, metabolic diseases or environmental factors. Their evidence shows evaluative thinking, considering both causes and consequences of biochemical imbalances. They integrate scientific knowledge with case studies or research findings, demonstrating a sophisticated understanding of how molecular dysfunctions affect organismal health and development.

For merit standard, students provide more detailed accounts, linking molecular structure to specific functions within biological systems. They interpret how features such as bonding, molecular shapes and chemical properties enable biological molecules to perform essential roles, including energy storage, catalysis and genetic coding. Their evidence includes examples from real-world applications, demonstrating an ability to explain how molecular characteristics underpin practical uses in biotechnology, medicine or industry.

For pass standard, students demonstrate foundational understanding by accurately identifying and describing the basic structures of biological molecules such as water, carbohydrates, proteins, nucleic acids and lipids. Their work shows recognition of key components and bonding types, and they can outline the general roles these molecules play in living organisms. Evidence includes clear explanations using correct terminology and the ability to relate molecular structure to biological function in straightforward contexts.

Learning aim B

For distinction standard, students evaluate the impact of harmful substances – such as tobacco, drugs, and pollutants – on respiratory efficiency, considering both immediate and chronic effects. Their evidence demonstrates critical judgement, integrating scientific research and data to assess how these factors compromise respiratory pathways. They may reference innovative monitoring techniques or recent studies, showing an advanced understanding of the interplay between environmental and biological influences on respiration.

For merit standard, students analyse data to interpret how physical activity alters respiratory function, using primary or secondary sources to support their explanations. They explain the physiological responses to exercise, such as increased oxygen demand and carbon dioxide output, and discuss the short-term and long-term effects on the respiratory system. Their evidence includes reasoned analysis of data trends and the ability to explain the mechanisms underlying observed changes.

For pass standard, students accurately outline the stages of human respiration, including aerobic and anaerobic pathways, and describe factors that influence respiratory efficiency. Their evidence includes clear sequencing of respiratory processes and identification of variables such as oxygen availability, exercise and exposure to pollutants. They demonstrate the ability to relate these factors to changes in breathing rate and gas exchange.

Learning aim C

For distinction standard, students evaluate the effects of various factors on photosynthetic efficiency, considering both natural and artificial influences. Their evidence includes critical assessment of strategies to enhance photosynthesis, such as genetic engineering, climate adaptation or advanced farming techniques. They integrate scientific reasoning with evaluative commentary, demonstrating a comprehensive understanding of how photosynthetic pathways can be manipulated for improved plant productivity.

For merit standard, students analyse data to interpret how different factors affect photosynthetic rates, using experimental results or literature sources. They explain the roles of pigments, environmental conditions and technological innovations in optimising photosynthesis. Their evidence demonstrates the ability to draw conclusions from data and to relate findings to practical applications in agriculture or environmental management.

For pass standard, students explain the stages of photosynthesis, including light-dependent and light-independent reactions, and identify key factors that influence the rate of photosynthesis. Their evidence includes accurate descriptions of processes and recognition of variables such as light intensity, carbon dioxide concentration and temperature.

 © Pearson Education Limited 2026

Links to other units

The assessment for this unit will draw upon some of the underpinning knowledge, understanding and skills covered in

- Unit 1: Principles and Applications of Biology
- Unit 6: Health Challenges and Medical Innovations
- Unit 16: Human Body Systems: Physiology, Disorders and Therapy
- Unit 20: Human Body Systems: Regulation, Control and Reproduction.

 © Pearson Education Limited 2026

Unit 15: Applications of Physical, Inorganic and Organic Chemistry

Level: 3

Unit type: Internal

Guided learning hours: 60

Unit in brief

Students explore the application of physical chemistry in the production of energy from electrochemical cells and fuels. They will explore the application of inorganic chemistry in agriculture and the manufacture of fertilisers, and the application of organic chemistry in the synthesis and use of medicines.

Unit introduction

Chemistry shapes everyday life through the materials we use and the reactions that underpin living systems. This unit introduces key applications of physical, inorganic and organic chemistry in fields such as energy, agriculture and medicine. Learners examine how core chemical principles support modern technologies, building both theoretical knowledge and practical laboratory skills.

In this unit, you will study energy generation using electrochemical and fuel cells, including constructing cells, measuring voltages and using standard electrode potentials. You will deepen understanding of combustion through bond energies, enthalpy, entropy and Gibbs free energy. Agricultural chemistry topics include acids and bases, fertiliser synthesis, equilibrium, pH calculations, titration curves and buffers. You also investigate organic synthesis for medical use, identifying functional groups, predicting properties, producing a compound and evaluating yield and purity.

Completing this unit provides a foundation for advanced study in analytical, industrial or pharmaceutical chemistry, and supports careers in research, healthcare, energy and environmental sustainability.

Learning aims

In this unit, you will:

A Explore the application of physical chemistry in producing energy from electrochemical cells and fuels

B Explore the application of inorganic chemistry in agriculture and the manufacture of fertilisers

C Explore the application of organic chemistry in the synthesis and use of medicines.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Explore the application of physical chemistry in producing energy from electrochemical cells and fuels	**A1** Cell batteries and fuel cells **A2** Electrochemical cells and redox reactions **A3** Energetics in the combustion of fuels	A report or presentation on the use of electrochemical cells and combustion of fuels to provide energy for vehicles.
B Explore the application of inorganic chemistry in agriculture and the manufacture of fertilisers	**B1** Fertilisers **B2** Acid-base chemistry	A mini-website or illustrated briefing on acid-base chemistry in agriculture and fertilisers.
C Explore the application of organic chemistry in the synthesis and use of medicines	**C1** Organic molecules in medicine **C2** Functional Group chemistry **C3** Aromatic chemistry **C4** Mechanisms and isomerism **C5** Practical organic synthesis **C6** Analytical techniques	A scientific report or presentation on synthesis and use of organic molecules in medicine.

Content

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

Learning aim A: Explore the application of physical chemistry in producing energy from electrochemical cells and fuels

A1 Cell batteries and fuel cells

- Components of cells – cathode, anode, electrolyte, separator.
- Primary cells (non-rechargeable), e.g. alkaline battery cells, zinc-carbon battery cells, silver oxide battery cells, lithium battery cells.
- Secondary cells (rechargeable), e.g. lead-acid battery, nickel-cadmium battery cell, nickel-metal hydride battery cell, lithium-ion battery cell.
- Fuel cells, e.g. alkaline hydrogen-oxygen fuel cell, direct methanol fuel cell, polymer electrolyte membrane (PEM) fuel cell, solid oxide fuel cell.

A2 Electrochemical cells and redox reactions

- Electrochemical cells:
  - equipment and techniques for measuring cell voltage
  - half cells using metal in solution of its own ions
  - half cells using platinum for non-metal elements or solutions of ions
  - use of cell diagram notation e.g. $Zn(s) | Zn^{2+}(aq) ¦¦ Cu^{2+}(aq) | Cu(s)$.
- Standard electrode potential (E^{θ}):
  - definition
  - standard hydrogen electrode (as a reference)
  - standard conditions (100 kPa, 298 K and 1 molar solutions).
- Calculation of cell voltage using table of standard electrode potentials:
  - comparison with experimentally determined values
  - predicting the feasibility of a redox reaction
  - understanding the limitations of predictions.
- Reduction and oxidation definitions.
- Reducing agent and oxidising agent definitions.
- Oxidation number – rules and assigning numbers.
- Redox and half equations:
  - identifying oxidised and reduced species
  - constructing and balancing equations in terms of number of electrons transferred
  - deriving redox equations from half equations and vice versa.

- Redox reactions, e.g. displacement reactions for metals and halogens, halide-thiosulfate reactions, iron(II) - manganate(VII) reactions, chromate(VI) reactions.

A3 Energetics in the combustion of fuels

- Organic compounds used as fuels, e.g. alkanes, alcohols, methyl esters (biodiesel).
- Combustion of organic compounds:
  - construct and balance chemical equations
  - products of complete and incomplete combustion.
- Energetics:
  - bond dissociation energies to calculate enthalpy changes
  - standard enthalpy change (ΔH^{θ})
  - entropy change (ΔS^{θ})
  - Gibbs free energy (ΔG^{θ})
  - $\Delta G^{\theta} = \Delta H^{\theta} - T\Delta S^{\theta}$
  - feasibility of a reaction.

Learning aim B: Explore the application of inorganic chemistry in agriculture and the manufacture of fertilisers

B1 Fertilisers

- Importance of fertilisers to grow food crops for an increasing world population.
- Elemental composition of fertilisers and purpose, e.g. nitrogen, phosphorus, potassium.
- Inorganic fertilisers – salts, e.g. ammonium nitrate, calcium phosphate, potassium chloride.
- Organic fertilisers, e.g. urea, manure, crop, compost.
- Formulations of fertilisers.
- Calculating the percentage element composition.
- Laboratory synthesis of a salt by acid-base titration using an indicator and volumetric glassware.
- Industrial manufacture of NPK fertilisers, including processes to make:
  - ammonia
  - nitric acid
  - sulphuric acid
  - phosphoric acid.
- Sources and processing of minerals, e.g. potassium chloride, calcium phosphate.
- Environmental impacts of fertiliser production and use, e.g. sourcing raw materials, industrial processes, increased crop yields, eutrophication, soil degradation, water and air pollution.

B2 Acid-base chemistry

- Definitions:
  - acid, base and alkali (Arrhenius, Brønsted-Lowry and Lewis theories)
  - conjugate acids and bases
  - strong, weak, concentrated, dilute.
- Concentration of strong or weak acids and alkalis.
- pH scale, pH = –log[H^+] and [H^+] = 10^{-pH}.
- Acid dissociation constant, K_a:
  - use the expression $K_a = \frac{[H^+][A^-]}{[HA]}$ to determine pH for a weak acid (HA ⇌ H+ + A-)
  - calculate Ka from pH
  - assumptions made in calculations
  - magnitude of Ka related to degree of dissociation
  - pKa = –log Ka.
- Ionic product for water, K_w:
  - dissociation of water (H_2O ⇌ H+ + OH-)
  - Kw = [H+][OH-] = 1 × 10-14 mol2 dm-6 (at 25°C)
  - use of Kw to calculate pH for strong alkalis
  - pKw = –log Kw.
- Buffer solutions:
  - definition
  - composition – a solution of a weak acid/base and a salt of the weak acid/base
  - use of pH = –log Ka + log $\frac{[A^-]}{[HA]}$ for a buffer solution (Henderson-Hasselbalch equation)
  - applications in acidity/alkalinity regulation.
- Carry out pH titrations for:
  - strong acid with strong alkali or weak alkali
  - weak acid with strong alkali or weak alkali.
- Use and calibration of a pH meter during titration.
- Understanding the features of pH/volume titration curves:
  - general shape
  - start and finish points
  - equivalence point
  - regions of buffering.
- Applications of acid-base chemistry in agriculture:
  - manufacture of fertilisers
  - treatment of soil and of water
  - improving nutrient availability for plants

  - reducing uptake of toxins by plants
  - treatment of insect bites and stings.

Learning aim C: Explore the application of organic chemistry in the synthesis and use of medicines

C1 Organic molecules in medicine

- Examples of organic molecules in medicine, e.g. aspirin, paracetamol.
- Pharmacophores – definition and components:
  - functional groups (e.g. double/triple bonds, halogen groups, hydroxyl, ether link, carbonyl, carboxyl, ester, amine, amide)
  - structure (e.g. saturated, unsaturated, aliphatic, branched, cyclic, heterocyclic, aromatic)
  - molecular shape.
- Factors that affect pharmacophore interaction with receptor sites.
- Isomerism – structural isomerism, stereoisomerism (geometric and optical).
- Polarity and intermolecular forces.
- Solubility:
  - water soluble, hydrogen bonding, ionic interaction – short retention time in body
  - fat-soluble, London dispersion forces – longer retention time in the body.
- Acid-base nature of functional groups and formation of salts.
- Oxidation/reduction of functional groups.
- Hydrolysis/condensation of functional groups.

C2 Functional group chemistry

Students must be able to name and draw/write formulae for organic compounds:

- Alcohols and ethers:
  - recap of reactions of alcohols (oxidation, elimination, condensation/esterification)
  - ether formation - dehydration of alcohols, halogenoalkanes with alkoxide ions.
- Aldehydes and ketones (carbonyl compounds):
  - nucleophilic addition, e.g. with HCN
  - oxidation of aldehydes (e.g. acidified K2Cr2O7), resistance to oxidation by ketones
  - reduction, e.g. with NaBH4 or LiAlH4
  - addition-elimination, e.g. with hydrazines
  - reaction with Grignard reagents to extend the carbon chain.
- Carboxylic acids and esters:
  - weak acidity of carboxylic acids, reaction with metals, bases, alkalis and carbonates
  - condensation reaction of carboxylic acids with alcohols to form esters
  - acid and alkaline hydrolysis of esters back into alcohol and carboxylic acid/salt.

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

- Acyl chlorides and acid anhydrides:
  - reactions with water, alcohols, ammonia and amines
  - comparison of reactivity with carboxylic acids.
- Amines:
  - structural features – lone pair of electrons; primary, secondary and tertiary
  - importance as bases and nucleophiles in reactions
  - nucleophilic substitution, e.g. with halogenoalkanes
  - condensation reaction with acyl chlorides and carboxylic acids to form amides.
- Amides:
  - alkaline and acid hydrolysis of amides into amine and carboxylic acid (or salts).
- Nitriles:
  - reduction and hydrolysis.
- Difunctional molecules and reactions, e.g. amino acids, lactic acid.
- Equations and conditions for all reactions.

C3 Aromatic chemistry

Students must be able to name and draw/write formulae for aromatic compounds:

- Benzene (C_6H_6):
  - structure and bonding
  - comparison of reactions with alkanes and alkenes (e.g. bromine, hydrogen)
  - electrophilic substitution, e.g. nitration, sulfonation, Friedel-Crafts reactions (chlorination, alkylation and acylation).
- Monosubstituted aromatic compounds (e.g. $–CH_3$, –OH, $–OCH_3$, $-NH_2$, $–NO_2$, -COOH):
  - methylbenzene – properties, substitution (electrophilic and free radical), oxidation
  - phenol (C6H5OH) – properties, acidity, electrophilic substitution, condensation
  - nitrobenzene – electrophilic substitution, reduction and diazotisation.
- Comparison of conditions and products for electrophilic substitution used for benzene with monosubstituted aromatic reactions.
- Heterocyclic aromatic compounds – comparison of reactivity with benzene (e.g. pyridine, electrophilic and nucleophilic substitution).
- Equations and conditions for all reactions.

C4 Mechanisms and isomerism

- Free radical substitution mechanisms, e.g. alkanes with halogens:
  - formation of structural isomers and of by-products.
- Electrophilic addition mechanisms, e.g. alkenes with hydrogen halides:
  - formation of structural isomers from asymmetric alkenes.

- Nucleophilic addition mechanisms of carbonyl compounds:
  - formation of an optical stereoisomer or a racemic mixture.
- Nucleophilic substitution mechanisms of halogenoalkanes with amines and alkalis:
  - formation of an optical stereoisomer or a racemic mixture
  - formation of by-products.
- Electrophilic substitution of benzene and monosubstituted aromatic compounds:
  - activating and deactivating effect of substituent groups
  - formation of structural (positional) isomers.

C5 Practical organic synthesis

- Examples of preparation of organic compounds, e.g. aspirin, paracetamol.
- Use of a range of practical techniques, e.g. heating under reflux, distillation, solvent extraction, filtration, recrystallisation, methods of drying.
- Determination of percentage yield and purity, e.g. melting/boiling point, thin layer chromatography.
- Factors affecting yield and purity, e.g. incomplete reactions, side reactions, conditions, limiting reagents, volatility, transfer losses, by-products.

C6 Analytical techniques

- Chromatography, e.g. gas chromatography (GC), high-performance liquid chromatography (HPLC):
  - chart layout – retention time and absorption/relative intensity
  - retention time as a measure of a component's identity (qualitative)
  - area under the peak as a quantitative measure.
- Mass spectroscopy (MS):
  - spectra in terms of mass to charge ratio (m/z) and relative abundance
  - determination of relative molecular mass from the molecular ion peak
  - interpretation of fragmentation patterns to identify structural features.
- Infrared (IR) spectroscopy:
  - spectra in terms of wavenumber (cm-1) and transmission
  - use of wavenumber correlation chart to identify functional groups
  - use of transmission peak intensity to determine quantities of compounds.
- ^{1}H (proton) and ^{13}C nuclear magnetic resonance (NMR) spectroscopy:
  - spectra in terms of chemical shift (δ in ppm) and relative intensity/peak area
  - number and type of chemically equivalent environments present for H or C atoms
  - use of correlation charts to identify environments present in an organic compound
  - area under peak (integration) relating to the number of H or C atoms present
  - simple peak splitting patterns and use of the n + 1 rule.

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

Assessment criteria

Learning aim A: Explore the application of physical chemistry in producing energy from electrochemical cells and fuels

Pass	Merit	Distinction
A.P1 Describe how primary, secondary and fuel cells are designed to produce energy. **A.P2** Investigate the energy produced from a series of electrochemical cells. **A.P3** Explain how energy is produced from the combustion of organic compound fuels.	**A.M1** Analyse the feasibility of redox reactions for electrochemical cells and of combustion reactions using standard electrode potentials and energetics.	**A.D1** Evaluate the use of electrochemical cells and of combustion reactions to produce energy for vehicles.

Learning aim B: Explore the application of inorganic chemistry in agriculture and the manufacture of fertilisers

Pass	Merit	Distinction
B.P4 Describe acid-base chemistry used in fertiliser manufacture and other agricultural uses. **B.P5** Synthesise a salt for use as a fertiliser.	**B.M2** Calculate concentration, pH and equilibrium dissociation constants for a range of acids and bases. **B.M3** Explain the action of buffers to maintain the pH of soil.	**B.D2** Analyse the changes that occur during acid-base titrations using pH curves.

Learning aim C: Explore the application of organic chemistry in the synthesis and use of medicines

Pass	Merit	Distinction
C.P6 Describe how features of organic compounds influence the use and action of medicines. **C.P7** Synthesise and purify an organic compound used for a medical application. **C.P8** Explain how analytical techniques are used to identify an organic compound for a medical application.	**C.M4** Explain functional group and aromatic chemistry in medicines, linking reactions and mechanisms to medicinal synthesis. **C.M5** Assess the yield and the purity of the organic compound synthesised.	**C.D3** Evaluate synthetic routes for organic compounds that have a medical application. **C.D4** Analyse how isomers are produced in synthesis using a range of organic mechanisms.

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 a part of wider teaching and learning
√	Embedded in teaching, learning and assessment
blank	Not embedded or signposted in unit

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments. There is also further information on our website.

There is a maximum number of 3 summative assignments for this unit.

The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.P3, A.M1, A.D1)

Learning aim: B (B.P4, B.P5, B.M2, B.M3, B.D2)

Learning aim: C (C.P6, C.P7, C.P8, C.M4, C.M5, C.D3, C.D4)

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- Chemicals, such as metals, acids, alkalis and organic compounds.
- Voltmeters.
- Volumetric glassware (pipettes, burettes, conical flasks).
- Indicators.
- pH meters.
- Glassware (condensers, round-bottom flasks, still heads).
- Thermometers.
- Filtration apparatus.
- Access to water and natural gas supplies.

Essential information for assessment decisions

Learning aim A

For distinction standard, students research and evaluate the use of electrochemical cells and fuel combustion in a vehicle of their choice. This evaluation should include consideration of factors such as the availability and sourcing of raw materials, energy density, energy efficiency, pollutants, refuelling/recharging and storage on board the vehicle. Students will support their evaluation with chemical equations, energetics and standard electrode potential data. The evaluation must include a justified conclusion on whether an electrochemical cell or combustion of a fuel is best for the vehicle's energy requirements.

For merit standard, students predict whether given redox equations are feasible. They will construct cell diagrams and redox equations from half equations, use standard electrode potentials to determine the cell voltage, and state whether the electrochemical cell reaction is feasible. Based on the information provided, students will propose an electrochemical cell that produces the greatest cell voltage. Students will also prove that given combustion reactions are feasible by calculating entropy changes, standard enthalpy changes of combustion, and Gibbs free energy changes. Additionally, they will determine the temperature at which the reactions are no longer feasible.

For pass standard, students describe the composition of at least one example of a primary cell, a secondary cell and a fuel cell. Evidence will include annotated diagrams of each cell, with the function or process occurring. For each cell, students will include the reduction and oxidation half equations, the overall redox reaction for the cell, and calculations of the cell voltage using standard electrode potentials.

Students will construct three electrochemical cells and measure the cell voltages produced. For one of the electrochemical cells, students should also investigate changing the concentration of solutions and observe the effect on the cell voltage. A report on the investigation will include annotated images of the cells and accompanying cell diagrams. For each electrochemical cell, the report will include reduction and oxidation half-reactions, overall redox reactions, and a comparison of the measured cell voltages with those calculated from standard electrode potentials. Students will also suggest electrochemical cells that could produce higher cell voltages.

Students will write combustion equations for different types of organic compounds: an alkane, an alcohol and a methyl ester. Using bond energies, they will calculate the enthalpy change of combustion and use it to explain how energy is released. Full working must be shown, but students can use spreadsheets to create formulae to perform the calculations.

Learning aim B

For distinction standard, students carry out titrations to explore changes in pH for at least two acid-base reactions using different combinations of strong and weak substances (students may share results with other members of the class to cover all combinations, but every student must have participated in obtaining results in at least two titrations). Each titration will be carried out by adding the alkali to the acid until a large excess is obtained. The alkali will initially be added in 1 cm^3 volumes, then in 0.1 cm^3 steps as the equivalence point is approached, and then once again in 1 cm^3 volumes. The pH at each volume will be measured with a calibrated pH meter. Students will plot a curve of pH against volume of alkali added, which can be drawn as a graph or using a spreadsheet, provided students can proficiently create the curve. Students will analyse these plots to explain the shape of the pH curves for each titration. They will use acid-base equations, buffer action theory and calculations involving [H+] = 10-pH to explain points where the pH changes and remains constant. For the pH curve of the weak acid/strong alkali, students will determine the acid dissociation constant, Ka, for the weak acid, using the pH of the half-neutralised solution and the relationships pH = pKa and Ka = 10-pKa.

For merit standard, students solve a series of problems to calculate concentration, pH values and equilibrium dissociation constants for a range of acids and bases. Problems will be set within the context of fertilisers and agriculture, and should be mix of routine and non-routine calculations. Students will need to show their working out for all problems. To assist them, students may create formulae in spreadsheets but there must be accompanying notes to identify and explain the formulae being used. It is not essential that every calculation is correct, but the majority of problems will be expected to be clearly and correctly solved to satisfy the coverage of the criterion.

Students will research at least two buffer solutions that are used to maintain the pH of soil. Examples of plants or crops that need acidic or alkaline soil conditions to grow should be given, and consequences if the pH is not maintained. One of the buffer solutions chosen must regulate acidity and another solution chosen must regulate alkalinity. The composition of each buffer solution must be identified and explained. The action of each buffer to maintain the pH when an acid or a base is added to the soil must be explained with reference to a series of equations. Students must also give example calculations to show how the pH is maintained and when it changes if the amount of acid or alkali exceeds what the buffer composition can cope with.

For pass standard, students describe the main concepts of acid-base chemistry using the context of fertiliser manufacture and other agricultural processes. The use, importance and issues of fertilisers will be described. Students can create a flow chart of an industrial NPK fertiliser plant. The key substances and reactions in the diagram can be further described using definitions and examples of acids and bases. Evidence must include examples of weak and strong acids/bases, conjugate acid-base relationships, neutralisation and the salts formed, and references to pH and concentration. Reactions must be illustrated with chemical and ionic equations. Other acid-base chemistry applications in agriculture, such as raising and lowering the pH of soil or of the water used for irrigation, must also be described.

Students will make an ammonium salt that can be used as a fertiliser. Students will use volumetric glassware and perform acid-base titrations, both with and without an indicator, to make the salt. The pure salt must then be obtained from the solution. Students must test the effectiveness of their salt as a fertiliser by adding it to the soil of plant seeds, monitoring the growth and comparing this against a control. The percentage composition of nitrogen in the salt will be calculated and compared against other nitrogenous fertilisers.

Learning aim C

For distinction standard, students create and evaluate synthetic routes for selected organic compounds with a medical application. The selected organic molecules should have functional groups students are familiar with and structures that are not overly complex. Students will apply and connect several different chemical reactions in a series of steps. These will be reactions studied in this unit, but more advanced reactions by students could be researched. For each chemical reaction suggested, conditions and organic synthetic techniques should be given. They will then evaluate the feasibility of the synthetic routes. For example, whether there may be a competing side reaction or the possibility of isomers forming.

Students will explain if isomers of their target organic molecules may be produced in their synthetic routes by analysing organic mechanisms for the reactions. Students can hand-draw or use software packages to create their illustrations, but sourced diagrams must not be used.

For merit standard, students should demonstrate movement beyond description and practical completion to secure, applied understanding of how organic chemistry concepts underpin medicinal use and synthesis. They accurately interpret structural formulae of medicinal compounds, selecting relevant functional groups and aromatic systems and explaining their chemical behaviour within realistic medicinal contexts. Reaction equations and mechanisms are applied purposefully, showing how transformations support synthesis rather than presented in isolation. Explanations are logically sequenced and chemically precise, with correct use of terminology, symbols and reaction conditions. Students make clear links between structural features, reaction pathways and the properties or effectiveness of medicines. Evidence is strengthened as students justify chemical choices, interpret outcomes from synthesis or analysis, and demonstrate consistency across written explanations, calculations, reaction schemes and supporting diagrams.

For pass standard, students examine the structural formulae of a range of organic molecules used in medicine. Students should outline what is meant by the term pharmacophore and how an organic molecule interacts with the human body and receptor sites to act as a medicine. Students will identify functional groups, structural features and isomerism within selected molecules. Students can then describe relevant physical properties and chemical activity in the human body. For example, solubility could be explored, as could interactions with the target receptor site and chemical responses to conditions in the body that are acidic, basic or involve oxidation.

Students will synthesise an organic compound used as a medicine and then purify it. Students will be expected to use some of the practical techniques that are listed under C5 in their synthesis and purification.

Students will explain how analytical techniques in chromatography and spectroscopy could be used to identify the organic compound that they have synthesised. MS, IR and NMR spectra for the organic compound and a chromatogram of the reaction mixture could be sourced and interpreted by the student. Alternatively, students could provide a general description of the chromatogram, including relative retention times and peak heights for the reaction mixture at different stages. Expected features of MS, IR and NMR spectra could be described to support the relative molecular mass, structural formula and functional groups of the organic compound, and reference to features that might indicate how pure it may be.

Links to other units

The assessment for this unit will draw upon some of the underpinning knowledge and understanding covered in content areas C and D covered in:

- Unit 2: Principles and Applications of Chemistry
- Unit 7: Chemical Principles and Reaction Systems.

Unit 16: Human Body Systems: Physiology, Disorders and Health Solutions

Level: 3

Unit type: Internal

Guided learning hours: 60

Unit in brief

This unit explores the digestive, endocrine and nervous systems, including homeostasis and disease management. Students cover structure, function, disorders and modern treatments, linking theory to real-world health contexts.

Unit introduction

This unit is relevant to the real world, as it equips students with essential knowledge of how the human body maintains health through the digestive, endocrine and nervous systems. Understanding these systems is important for recognising the impacts of diet, lifestyle and environmental factors on physical and mental wellbeing. Students gain insight into common diseases, modern treatments and the role of technology in monitoring and managing health, which reflects current trends in healthcare and public health.

In this unit, you will learn the structure and function of the digestive system, including the role of the microbiome and corrective treatments for dietary-related diseases. You will explore the nervous and endocrine system, examining hormonal regulation, neural pathways and the impact of disorders such as diabetes and Alzheimer's.

This unit prepares students for further study in health and science disciplines, as well as for employment in roles where critical thinking, problem solving, and the ability to apply scientific principles to human health are essential. The unit fosters transferable skills and a holistic perspective, laying a strong foundation for careers in healthcare, research and beyond, and enabling informed decision making and promoting lifelong health.

Learning aims

In this unit, you will:

A Explore the physiology of the digestive system and use of corrective treatments for dietary-related diseases

B Understand the structure and function of the endocrine system and their roles in health and disease

C Understand the structure and function of the nervous system and its relationship with digestive and endocrine systems when regulating body functions.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Explore the physiology of the digestive system and use of corrective treatments for dietary-related diseases	**A1** Structure of the digestive system **A2** Function of the digestive system **A3** Health matters and treatments related to the digestive system	Laboratory book, audio-visual materials and evidence of practical work.
B Understand the structure and function of the endocrine system and their roles in health and disease	**B1** Endocrine system **B2** Disorders of the endocrine system	Presentation or booklet exploring the endocrine system and hormones.
C Understand the structure and function of the nervous system and its relationship with digestive and endocrine systems when regulating body functions	**C1** Nervous system **C2** Disorders of the nervous system **C3** Interrelationship between systems	Presentation or booklet exploring the nervous system and its relationship with other systems.

Content

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

Learning aim A: Explore the physiology of the digestive system and use of corrective treatments for dietary-related diseases [MY – TPR]

A1 Structure of the digestive system

- Location and structural features of the following parts of the digestive system and associated organs:
  - mouth, tongue, pharynx, oesophagus, stomach, small intestine (duodenum, jejunum, ileum)
  - large intestine, rectum, anus
  - small intestine layers (longitudinal muscle, circular muscle, submucosa, mucosa, villi)
  - role of intestinal microbiome in digestion, immunity, mental health (gut-brain axis)
  - associated organs: pancreas, liver, gall bladder.

A2 Function of the digestive system

- Processes involved in digestion, absorption and assimilation of nutrients:
  - mechanical and chemical digestion
  - peristalsis (oesophagus and small intestine)
  - action of enzymes (protease, pepsin, amylase, maltase, dextrinase, lipase, bile, hydrolysis)
  - assimilation
  - liver's role in nutrient storage and regulation (glucose/glycogen, iron and red blood cell recycling, vitamin A, vitamin D, cholesterol conversion)
  - impact of probiotics, prebiotics, fermented food
  - egestion.

A3 Health matters and treatments related to the digestive system

- Dietary sources and importance of macronutrients and micronutrients, including symptoms of deficiencies – fibre, lipids, protein, water, carbohydrates, vitamins (A, B, C, D) and minerals (iron, magnesium and iodine).
- Digestive system diseases and physiological reasoning behind treatments, including coeliac disease, irritable bowel syndrome, colitis, non-coeliac gluten sensitivity, microbiome imbalance.
- Stomach ulcers, *Helicobacter pylori* and proton pump inhibitors (PPIs).
- Jaundice and non-alcoholic fatty liver disease.
- Gallstones.

- Bariatric surgery, personalised nutrition planning, Glucagon-like peptides (GLP) (medication for weight loss).
- Digital tools for dietary tracking, e.g. AI-based nutrition analysis apps, digital sensors, wearable monitors.

Learning aim B: Understand the structure and function of the endocrine system and their roles in health and disease

B1 Endocrine system

- Target cells and organs, ductless glands, endocrine glands, exocrine glands, hormones, transported in blood.
- Hypothalamus – control of pituitary gland via releasing hormones, control of daily circadian rhythms with melatonin and pineal gland, target for leptin.
- Thyroid gland – regulation of growth, protein synthesis and basal metabolic rate (thyroxine) and function of many body systems, role in regulation of blood calcium levels (calcitonin).
- Pancreas – regulation of blood sugar:
  - secretion of insulin and glucagon by beta and alpha cells in the Islets of Langerhans
  - glycogen, glucose, glycogenesis, glycogenolysis, glucogenesis, gluconeogenesis.
- Adrenal glands – the ‘fight-or-flight’ response via the hormone adrenaline, regulation of blood pressure via the hormone aldosterone, cortisol and stress.
- Pituitary gland – control of growth, function of sex organs (FSH, LH), osmoregulation (ADH and the kidney), prolactin and oxytocin.
- Ovaries – production of oestrogen and progesterone (sex hormones).
- Testes – production of androgen hormones, which are involved in the development of maleness and the production of sperm.

B2 Disorders of the endocrine system

- Significance and impact of:
  - under production of hormones, e.g. Hashimoto thyroiditis (hypothyroidism), type 1 diabetes, Addison’s disease
  - overproduction of hormones, e.g. gigantism (acromegaly), polycystic ovary syndrome, Cushing’s disease, Graves’ disease (hyperthyroidism) syndrome of inappropriate antidiuretic hormone (SIADH)
  - hormone insensitivity disorders, e.g. type 2 diabetes
  - advances in hormone therapy (animal-derived hormones, hormones from genetic modification, ethical issues)
  - surgical treatments
  - radiotherapy
  - impact of endocrine disruptors (plastics, chemicals).

- Wearable technology for glucose monitoring, AI-based diabetes management.
- Feedback mechanisms in artificial organs.
- Machine learning in predicting imbalances.

Learning aim C: Understand the structure and function of the nervous system and its relationship with digestive and endocrine systems when regulating body functions

C1 Nervous system

- Components, organisation and role of the central nervous system (CNS):
  - brain and spinal cord, motor neurons, sensory neurons, nerve cells, reflex arc, synapses, neurotransmitters (excitatory and inhibitory)
  - areas of the brain: hindbrain (medulla oblongata, cerebellum and reticular activating system), midbrain and forebrain (cerebrum, thalamus, hypothalamus)
  - cerebrum: made of two large hemispheres with four lobes (frontal, parietal, occipital, temporal)
  - coordination of both voluntary and involuntary activities of the body
  - conduction of nerve impulses to and from the CNS
  - sensory organs structure and function:
    - eye
    - ear
  - the peripheral nervous system (PNS):
    - nerves and ganglia outside the brain and spinal cord
    - somatic nervous system
    - autonomic nervous system (the parasympathetic nervous system and the sympathetic nervous system)
- Neuroplasticity, impact of digital stress, brain-computer interfaces in healthcare.

C2 Disorders of the nervous system

- Students will understand the causes, mechanisms and symptoms of degenerative diseases, such as:
  - Parkinson’s disease
  - Alzheimer’s disease
  - multiple sclerosis (MS)
  - motor neurone disease.
- Impact of lifestyle on neurodegeneration.
- Emerging treatments, e.g. stem cell therapy.
- Cochlear implants and the ear.
- Myopia, hypermetropia, astigmatism and the eye.

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

C3 Interrelationship between systems

- Body temperature regulation (hypothalamus, thyroxin) to include:
  - vasodilation and vasoconstriction of arterioles leading to surface capillaries
  - pili erector muscles
  - sweat production
  - shivering
  - hyperthermia.
- Digestive system control:
  - swallowing
  - peristalsis
  - gastric secretion
  - hunger (leptin, adipose, hypothalamus, thyroid).
- Regulation of sleep rhythm (melatonin, hypothalamus, eye, pineal gland):
  - effect of jet lag
  - blue light from mobile phones and effect on sleep
  - SAD and light therapy
  - effect of stress and diet on sleep.
- Stages involved in the regulation of water (osmoregulation), to include roles of:
  - antidiuretic hormone (ADH), atrial natriuretic peptide (ANP), angiotensinogen, aldosterone
  - hypothalamus, pituitary gland
  - kidney nephron (endothelial cells)
  - Cl^-, Na^+, K^+ ions.

Assessment criteria

Learning aim A: Explore the physiology of the digestive system and use of corrective treatments for dietary-related diseases

Pass	Merit	Distinction
A.P1 Describe the location and role of organs involved in digestion. **A.P2** Explain sources and importance of key nutrients for a balanced diet. **A.P3** Describe symptoms of nutrient deficiency as a result of dietary-related disease.	**A.M1** Analyse the role of digestive enzymes in each part of the digestive system. **A.M2** Explain the use of corrective treatments for nutrient deficiency.	**A.D1** Evaluate the effect of dietary disease and corrective treatments on human health.

Learning aim B: Understand the structure and function of the endocrine system and their roles in health and disease

Pass	Merit	Distinction
B.P4 Describe the organisation and function of the endocrine system.	**B.M3** Analyse the treatments for endocrine system disorders.	**B.D2** Evaluate the impact of changes and disruptions to the hormonal systems over a typical lifetime.

Learning aim C: Understand the structure and function of the nervous system and its relationship with digestive and endocrine systems when regulating body functions

Pass	Merit	Distinction
C.P5 Describe the organisation and function of the nervous system.	**C.M4** Analyse treatments for nervous system disorders.	**C.D3** Critically evaluate the complex and interconnected relationship between the nervous, digestive and endocrine systems, and how they regulate body functions.

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

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 a part of wider teaching and learning
√	Embedded in teaching, learning and assessment
blank	Not embedded or signposted in unit

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments. There is also further information on our website.

There is a maximum number of 3 summative assignments for this unit.

The relationship of the learning aims and criteria is:

Learning aims: A (A.P1, A.P2, A.P3, A.M1, A.M2, A.D1)

Learning aim: B (B.P4, B.M2, B.D2)

Learning aim: C (C.P5, C.M4, C.D3)

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- Anatomical models, diagrams, and labelled charts of the digestive, endocrine and nervous systems.
- Access to digital nutrient analysis tools, food testing kits and wearable health monitors.
- Case studies and up-to-date clinical scenarios covering diseases, treatments and homeostasis disruptions.
- Interactive resources: simulation software, video tutorials and current research articles on emerging health themes.

Essential information for assessment decisions

Learning aim A

For distinction standard, students present a balanced evaluation of how dietary-related conditions affect health and how corrective treatments alter outcomes. Strong responses compare conditions such as coeliac disease, IBS/colitis, non-coeliac gluten sensitivity or microbiome imbalance, weighing physiological mechanisms against evidence for treatment effectiveness (e.g. elimination diets, supplementation, personalised nutrition plans). Discussion of risks, benefits and adherence is expected, and students may appraise when pharmacological management, bariatric surgery or microbiome-supportive strategies are indicated. Use of student-generated or provided data (symptom tracking, food diaries, digital monitoring) to support judgements strengthens the evaluation. Conclusions should be clearly reasoned, acknowledge limitations and individual variability, while justifying the most appropriate corrective approach for the presented scenarios.

For merit standard, students provide analysis that links where digestion happens to how it is catalysed, comparing enzyme actions (e.g. amylase, protease, lipase) at specific sites, and discussing factors such as pH and substrate specificity. Moving beyond the description, they interpret test or case data (e.g. simple diet logs) to explain suitable corrective responses to deficiencies, considering absorption, bioavailability and realistic dietary adjustments. Judicious inclusion of probiotics/prebiotics and fermented foods as supportive measures is acceptable when justified by mechanism. The work shows coherent reasoning, connecting symptoms to underlying physiology and targeted interventions, with clear explanations of why a particular corrective strategy is appropriate for the identified deficiency and context.

For pass standard, students evidence accurate identification and description of digestive tract regions and associated organs using labelled diagrams and clear prose (e.g. mouth to anus, duodenum/jejunum/ileum, liver, pancreas, gall bladder). They correctly outline the roles of these structures and show a secure grasp of key nutrient sources and their importance (macros and selected micronutrients), linking typical foods to functions. Indicators of secure achievement include the use of correct terminology (peristalsis, assimilation) and clear, relevant signs of common deficiencies and diseases. Appropriate references to the intestinal microbiome's contribution may be included at a descriptive level. Work is organised, largely accurate and shows that the student can relate structure to basic function and nutrition to health signs in a straightforward manner.

Learning aim B

For distinction standard, students evaluate how the endocrine system changes across the life course and the implications for health and physiological function. Strong work contrasts developmental stages (childhood, adolescence, adulthood, ageing), addressing events such as puberty, pregnancy, menopause/andropause, with reasoned comment on variability and functional impact. Students weigh normal adaptations against risks of dysregulation (e.g. endocrine disorders or altered stress responsivity) and may incorporate contemporary influences (digital stress, environmental disruptors) where relevant. Conclusions integrate both normal and disrupted function using precise biological terminology and consider the severity of disruptions and their impact on quality of life.

For merit standard, students analyse the treatments for endocrine disorders, such as diabetes and polycystic ovary syndrome, weighing the positive and negative outcomes for treatments, such as hormone replacement therapy and surgical procedures. Reasoned commentary links the effectiveness of treatment and monitoring strategies with potential side effects and impact on quality of life. Disorders are broken down into their underlying mechanisms, with the hormone, target organ and feedback mechanisms explained using accurate scientific terminology.

For pass standard, students provide a coherent description of the organisation and function of the endocrine system. Evidence might include annotated schematics of major glands (hypothalamus, pituitary, thyroid, adrenals, pancreas, ovaries/testes) with succinct hormone outputs and roles, alongside clear descriptions of feedback mechanisms. Appropriate terminology (e.g. adrenaline, insulin, glucagon) is used correctly, and typical examples illustrate how hormones travel and produce effects in target organs. A brief acknowledgement of contemporary context (e.g. endocrine disruptors; glucose monitoring technologies) can be included for relevance, but the focus remains on accurate descriptions of organisation and function. Overall, the work is accurate, systematic and shows a secure understanding.

Learning aim C

For distinction standard, students critically analyse how the nervous and endocrine systems interact to regulate body functions, with reference to the digestive system. They use biological terminology accurately and demonstrate synthesis by connecting regulatory pathways, such as those of osmoregulation and appetite. The effects of disorders or disruptions on these systems, and on other body systems, are evaluated in terms of how homeostasis is affected by interacting factors, such as stress or jet lag. Students may consider the practical value of monitoring and mitigation strategies, ranging from behavioural changes to assistive technologies, while acknowledging limitations and individual variability. Conclusions show critical judgement grounded in physiological principles and real-world relevance.

For merit standard, students analyse the treatments for nervous system disorders, including Parkinson's and hearing loss, weighing the positive and negative outcomes for interventions such as L-DOPA therapy and surgical procedures. Reasoned commentary links the effectiveness of treatment and monitoring strategies with potential side effects and impacts on quality of life. Disorders are broken down into their underlying mechanisms, using precise scientific terminology such as neurons, synapses and neurotransmitters.

For pass standard, students provide a coherent description of the organisation and function of the nervous system. Evidence might include annotated diagrams of the brain and sensory organs with clear descriptions of their roles. Appropriate terminology, such as autonomic, peripheral and somatic nervous systems, is used correctly.

Typical examples illustrate how signals travel and produce effects in target organs. A brief acknowledgement of the interactions between the nervous, endocrine and digestive systems may be included for relevance, but the emphasis remains on accurate organisation/function explanations. Overall, the work is accurate, systematic and shows secure understanding.

Links to other units

The assessment for this unit will draw upon some of the underpinning knowledge, understanding and skills covered in

- Unit 1: Principles and Applications of Biology
- Unit 6: Health Challenges and Medical Interventions
- Unit 13: Human Disease, Infection and Environmental Health
- Unit 20: Human Body Systems: Regulation, Control and Reproduction.

 © Pearson Education Limited 2026

Unit 17: Medical Instrumentation Techniques for Diagnosis and Therapy

Level: 3

Unit type: Internal

Guided learning hours: 60

Unit in brief

This unit explores the principles, uses and safety of non-ionising and ionising medical instrumentation techniques. Students gain practical understanding of modern diagnostic and therapeutic technologies in healthcare.

Unit introduction

This unit relates directly to modern healthcare by developing essential knowledge of medical instrumentation used in diagnosis and treatment. As technology advances rapidly, understanding ionising and non-ionising techniques is vital for medical, scientific and technical careers. Students learn how these methods influence patient care, safety and clinical effectiveness, preparing them for current healthcare challenges and innovations.

The unit covers a wide range of techniques, including MRI, lasers, infrared thermography, ultrasound, X-rays, CT, PET and radiotherapy. You will explore their principles, production and applications, alongside instrumentation, image analysis, safety, risks and regulation. The curriculum encourages critical thinking about AI integration, sustainability and patient-centred practice, ensuring a comprehensive understanding of medical instrumentation.

Completing this unit provides strong preparation for further study or employment in healthcare, biomedical engineering or medical physics. The skills developed support clinical, research and medical technology roles. Students gain analytical and evaluative abilities, building a foundation for higher education, professional qualifications and careers requiring knowledge of modern diagnostic and therapeutic technologies.

Learning aims

In this unit, you will:

A Explore non-ionising instrumentation techniques used in medical applications

B Explore ionising instrumentation techniques used in medical applications

C Understand importance of health and safety when using radiation in medical applications.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Explore non-ionising instrumentation techniques used in medical applications	**A1** Magnetic resonance imaging (MRI) **A2** Lasers **A3** Infrared thermography (IRT) **A4** Ultrasound	A research report on radiation techniques with visual representations and case studies.
B Explore ionising instrumentation techniques used in medical applications	**B1** X-rays **B2** Computerised tomography (CT) or computerised axial tomography (CAT) **B3** Gamma ray imaging **B4** Radiotherapy, Gamma Knife surgery and proton beam therapy	
C Understand importance of health and safety when using radiation in medical applications	**C1** Safety precautions, side effects and risks for operators and patients of non-ionising radiation **C2** Safety precautions, side effects and risks for operators and patients of ionising radiation	A report or presentation on risks and health and safety compliance linked to patients and operators.

Content

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

Learning aim A: Explore non-ionising instrumentation techniques used in medical applications

The principles, production, uses and benefits of non-ionising techniques, patient choices and consent.

A1 Magnetic resonance imaging (MRI)

- Uses radiofrequency waves and strong magnets to produce detailed images of soft tissues in the body.
- Increasingly, AI algorithms are used to enhance image quality, automate diagnosis and reduce scan times.
- Instrumentation/production – main, circular, strong, permanent, superconducting magnet cooled by liquid helium; MRI scanner coils; sliding platform; radio frequency waves input; output signal receiver linked to a powerful computer.
- MRI principles – from radio frequency input to output of high-resolution images (from protons in different environments) analysed by a radiologist; use of data image sets; interpretation of MRI images.
- Diagnostic uses – brain and spine, joints, blood vessels, heart conditions, abnormal body water conditions.
- Expanded diagnostic uses and AI-assisted protocols include early detection of neurodegenerative diseases, advanced cardiac imaging, whole-body screening.
- Benefits – non-contact, non-invasive, painless, portable and open MRI systems can be used for point-of-care diagnostics.

A2 Lasers

- Light of specific wavelength passes through a gain medium, which amplifies light with higher energy by stimulated emission.
- Reflectors send light back and forth through the gain medium until it has gained enough energy.
- High-energy amplified light emitted as a narrow beam or is spread out, depending on application, through a laser oscillator.
- Main types of medical lasers used for different procedures – carbon dioxide, argon, yttrium aluminium garnet (YAG), pulsed dye, femtosecond lasers for eye surgery, photobiomodulation therapy for wounds and pain management.
- Treatment, diagnosis and therapy uses – e.g. eye surgery, removal of kidney stones, removal of tumours, minimally invasive therapies for dermatology, dental procedures, targeted cancer treatments using robotic-assisted laser systems.

 © Pearson Education Limited 2026

- Benefits – can focus on a small area, causing less damage to surrounding tissue; less pain, swelling and scarring than with traditional surgery.

A3 Infrared thermography (IRT)

- An infrared thermographic camera produces thermal images (thermograms) that show areas of abnormal body temperature, 'hot spots' on the skin that result from higher blood flow due to tumours.
- Uses – e.g. in screening programmes, cardiovascular/circulatory disorders, respiratory problems, dentistry, remote patient monitoring, pandemic fever screening, early detection of diabetic foot complications.
- Benefits – fast, passive, non-contact and non-invasive, maps body surface temperature remotely.

A4 Ultrasound

- Used by radiologists and sonographers.
- Instrumentation – earthed case, coaxial cable, absorber, crystal and plastic cover, monitor screen.
- Pulses of ultrasound transmitted from the probe in the transducer into the body and reflected back.
- The density characteristics of the different structures within the body are displayed as an image, use of data image sets, interpretation of ultrasound images.
- Medical ultrasound is usually 2 megahertz (MHz) and higher-frequency ultrasound.
- Types:
  - external ultrasound scan, e.g. screening of fetus
  - internal ultrasound scan – produces images of organs in more detail
  - endoscopic ultrasound – long, thin flexible tube (endoscope) inserted into the body through mouth to examine stomach, gullet or lymph nodes in chest.
- Treatment uses – kidney stones, benign and malignant tumours.
- Diagnosis uses – narrowing of blood vessels, strokes and heart attacks, echocardiogram to measure blood flow rates, 3D/4D imaging, elasticity for tissue stiffness measurement, AI-powered portable devices and ultrasound for point-of-care diagnosis.

Learning aim B: Explore ionising instrumentation techniques used in medical applications

The principles, production, uses and benefits of ionising techniques, patient choices and consent.

B1 X-rays

- High-frequency rays, ionising radiation waves, pass through soft body tissue, absorbed by dense bones.
- Produces image on a photographic plate placed behind the required part of the body, image is processed by a computer.

- Image analysed by radiologist – AI-based image analysis to assist radiologists to improve accuracy and reduce workload.
- Digital X-ray systems can be more sustainable and reduce radiation exposure.
- Where X-rays are absorbed, e.g. by bones, they appear white; other areas are dark on the photographic film.
- X-ray imaging principles and production:
  - heated cathode filament produces negatively charged electrons
  - electrons accelerate to a positively charged tungsten anode, where some of their kinetic energy is transformed into X-rays
  - use of data image sets, interpretation of X-ray images.
- Treatment and diagnostic uses – cancers and breaks in bones, pneumonia, tuberculosis, screening for breast cancer, mammograms.

B2 Computerised tomography (CT) or computerised axial tomography (CAT)

- A series of X-rays creates detailed images, called tomograms, of the inside of the body, layer by layer.
- Image examined by radiologist, low-dose CT protocols and AI-assisted reconstruction techniques can be used to minimise radiation exposure and improve image quality.
- Use of data image sets, interpretation of CT images.
- CT scan is created by an X-ray tube that rotates around the body – the body is inside a tunnel and is moved continuously through a rotating beam of X-rays, a detector is on the opposite side of the body.
- Diagnosis and monitoring uses – brain tumours, certain bone conditions, injuries to internal organs such as the kidneys, liver and spleen, and the heart.

B3 Gamma ray imaging

- Principles include:
  - a short-lived, positron-emitting (positive electron e+) radioactive tracer (radionuclide) with a short half-life, e.g. iodine-123 (123I), technetium-99 (99T), is injected into the body
  - emitted positrons combine with nearby electrons (e-) to produce gamma rays
  - gamma ray emissions from the cancerous area produce an image for diagnosis
  - the body is inside a ring of detectors to give a signal, which is used by the computer to produce a three-dimensional functional image of inside of the body given off by a radiotracer.
- Uses of positron emission tomography (PET) – imaging scans for diagnosis of cancer, detection of recurrent tumours, combined with CT/MRI for hybrid scans improving anatomical and functional diagnosis, AI use for automated lesion detection and quantification.
- Benefits – high-energy, penetrating power.

B4 Radiotherapy, Gamma Knife surgery and proton beam therapy

- Radiotherapy – gamma rays externally or internally inside the body:
  - external beam radiotherapy uses linear accelerator, focuses high-energy gamma ray beams onto the area requiring treatment
  - a series of daily treatments over several days or weeks
  - uses – to treat cancerous tumours.
- Use of adaptive planning, real-time imaging and AI to personalise treatment and minimise side effects.
- Gamma Knife surgery:
  - a highly accurate therapeutic dose of gamma radiation for brain tumours
  - dose volume controlled for treatment required.
- Proton beam therapy:
  - an accelerator (synchrotron) accelerates charged protons accurately in a 3D pattern, giving greater control and precision and causing less damage to healthy cells
  - Bragg peak internal radiotherapy
  - cancerous cells lose ability to repair, divide and proliferate, causing cellular death
  - uses – to treat cancerous and benign (non-cancerous) tumours, thyroid disease and some blood disorders
  - benefits – non-invasive and painless, less damage to healthy tissues.

Learning aim C: Understand importance of health and safety when using radiation in medical applications

C1 Safety precautions, side effects and risks for operators and patients of non-ionising radiation

- Safe operating procedures for possible effects on patients and staff operators.
- Health and safety – legal and regulatory requirements.
- Ultrasound:
  - internal ultrasound scanner, placed into the vagina or rectum, can cause discomfort
  - endoscopic ultrasound – long, thin, flexible tube (endoscope) inserted into the body through the mouth can cause discomfort – patients are usually given painkillers and a sedative
  - for some scans, patients need to drink and retain a lot of water to fill their bladders or avoid eating for several hours.
- Lasers – treatment may not be permanent; use of protective clothing and laser safety goggles is necessary, exposure limits are necessary, use of film badges is required.
- MRI – quite noisy, can be claustrophobic in tunnel, safety related to use of powerful magnets, e.g. removal of all ferromagnetic materials, implants and foreign bodies.
- Cybersecurity for medical devices, data privacy regulations.

 © Pearson Education Limited 2026

C2 Safety precautions, side effects and risks for operators and patients of ionising radiation

- Safe operating procedures for possible effects on patients and staff operators.
- Health and safety – legal and regulatory requirements associated with using radiation in diagnosis, treatment and therapy and international standards for radiation protection.
- X-rays, CT, radiotherapy, proton beam therapy and gamma rays have high-energy penetrating power of ionising radiation, ionising radiation/medical exposure, legal and/or regulatory, national and international requirements:
    - safe operating procedures for ionising radiation applications and possible effects on patients and staff operators
    - occupational risk and exposure to high levels of radiation (100 mSv or more)
    - patient dose limits required
    - typical levels of exposure during medical tests in millisieverts (mSv), such as single chest x-ray (0.014 mSv); mammogram (0.4 mSv); CT scan of whole spine (10 mSv)
    - use of protective clothing and film badges required
    - use of simulation, Virtual Reality headset technology.
- Ionising radiation can damage healthy cells and cause cancer.
- CT scanning can be claustrophobic in the tunnel.
- Possible radiotherapy side effects are – tiredness, hair loss, loss of appetite, diarrhoea, sore skin.
- Gamma Knife surgery can cause discomfort in head control device but has fewer side effects than radiotherapy.
- Proton beam therapy has fewer harmful side effects.
- Importance of digital record-keeping, AI-based dose optimisation.
- Environmental impact and recycling of radioactive materials.

Assessment criteria

Learning aim A: Explore non-ionising instrumentation techniques used in medical applications

Learning aim B: Explore ionising instrumentation techniques used in medical applications

Pass	Merit	Distinction
A.P1 Explain how the principles and production of non-ionising radiation technologies are used in medical applications. **A.P2** Explain why non-ionising radiation technologies are used for diagnosis and treatment of human diseases.	**A.M1** Compare the principles, production and uses of different non-ionising radiation techniques used in medical applications.	**AB.D1** Justify the choice of non-ionising and ionising radiation techniques used in medical applications.
B.P3 Explain how the principles and production of ionising radiation technologies are used in medical applications. **B.P4** Explain why ionising radiation technologies are used for diagnosis and treatment of human diseases.	**B.M2** Compare the principles, production and uses of different ionising radiation techniques used in medical applications.	

Learning aim C: Understand importance of health and safety when using radiation in medical applications

Pass	Merit	Distinction
C.P5 Explain health and safety risks, side effects and limitations of non-ionising and ionising radiation technologies. **C.P6** Explain how hospitals can employ health and safety measures, when using instrumentation, for the protection of patients and operators.	**C.M3** Compare health and safety risks, side effects and limitations of non-ionising and ionising radiation technologies used in medical applications to maximise the protection of patients and operators.	**C.D2** Discuss consequences of poor health and safety when using radiation technologies and the prevention and safety measures employed.

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 a part of wider teaching and learning
√	Embedded in teaching, learning and assessment
blank	Not embedded or signposted in unit

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments. There is also further information on our website.

There is a maximum number of 3 summative assignments for this unit.

The relationship of the learning aims and criteria is:

Learning aims: A and B (A.P1, A.P2, B.P3, B.P4, A.M1, B.M2, AB.D1)

Learning aim: C (C.P5, C.P6, C.M3, C.D2)

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- Access to medical imaging equipment or high-quality simulations (MRI, CT, ultrasound, X-ray, PET) for demonstration and practical activities.
- Up-to-date textbooks, digital resources and case studies covering non-ionising and ionising instrumentation principles, uses and safety.
- Interactive software or online platforms for image analysis, safety scenario simulations and virtual labs.
- Current health and safety guidelines and regulatory outlines.

Essential information for assessment decisions

Learning aims A and B

For distinction standard, students produce an evaluation of both non-ionising and ionising instrumentation, integrating recent developments such as AI-assisted technologies, portable systems, hybrid imaging and advances in radiotherapy. Their work shows an in-depth understanding of underlying principles, modern applications and future directions in medical practice. Evidence includes clear analysis of how these technologies enhance diagnosis and treatment, with reference to regulatory, ethical and environmental considerations, and supported by current examples that reflect emerging healthcare challenges.

For merit standard, students provide detailed accounts of the instrumentation and production processes involved in non-ionising and ionising techniques, demonstrating an informed grasp of how these methods function in medical contexts. They interpret image data sets and technical information, compare different imaging and treatment modalities, and discuss their impact on patient care. Evidence includes analysis of advantages, disadvantages, benefits and risks, supported by examples that reflect established and developing applications.

For pass standard, students describe the principles and uses of non-ionising techniques such as MRI, lasers, infrared thermography and ultrasound, as well as ionising techniques such as X-rays, CT, PET and radiotherapy. Evidence includes clear explanations of how each technology operates and typical medical applications, referencing common conditions where appropriate. Their work shows accurate understanding of key benefits and limitations, supported by real-world examples, though explanations may be limited to well-known practices.

Learning aim C

For distinction standard, students critically evaluate health and safety, integrating recent developments such as cybersecurity, data privacy and sustainability. Their work demonstrates in-depth understanding of the complexities involved, considering both technical and ethical dimensions. Evidence includes discussion of how emerging risks are managed in modern healthcare, supported by examples of innovative safety solutions and regulatory updates.

For merit standard, students interpret health and safety issues in detail, discussing the implications of risks and side effects for different stakeholders. They provide examples of how safety measures are implemented and consider the impact on patient experience. Evidence includes analysis of legal and regulatory frameworks, with reference to current standards and practices.

For pass standard, students identify key safety precautions, risks and side effects associated with both non-ionising and ionising techniques. Evidence includes descriptions of standard procedures and legal requirements, showing awareness of how safety is maintained for patients and operators. Their work is accurate, but may focus on established protocols.

Links to other units

The assessment for this unit will draw upon some of the underpinning knowledge, understanding and skills covered in:

- Unit 6: Health Challenges and Medical Innovations
- Unit 13: Human Disease, Infection and Environmental Health
- Unit 16: Human Body Systems: Physiology, Disorders and Health Solutions
- Unit 20: Human Body Systems: Regulation, Control and Reproduction.

Unit 18: Modern Materials and Sustainable Technologies

Level: 3

Unit type: Internal

Guided learning hours: 60

Unit in brief

This unit explores the classification, properties and applications of materials, including nanotechnology and polymers, with a focus on sustainability and innovation.

Unit introduction

This unit introduces students to modern materials and technologies that support everyday life and future innovation. Understanding how materials—including metals, polymers, ceramics, composites and nanomaterials—are classified and applied is essential for addressing global challenges in sustainability and technological development. Students learn how materials science drives progress across construction, energy, healthcare, electronics and environmental protection.

The unit examines material classification and properties, progressing into nanotechnology and the strengths and limitations of polymer technologies. You will study materials at both macroscopic and microscopic levels, evaluate their environmental and health impacts and investigate how advanced materials support carbon-reduction strategies. This provides insight into how emerging technologies shape a more sustainable future.

Completing this unit builds a strong foundation for further study in science, engineering, construction or technology. Students develop analytical and evaluative skills valued in higher education and apprenticeships. The focus on sustainability and innovation prepares learners for careers in renewable energy, manufacturing, construction and environmental management.

Learning aims

In this unit, you will:

A Understand the classification and properties of different materials

B Examine the uses, benefits and limitations of developing nanotechnology materials

C Investigate benefits and limitations of polymer technology

D Examine materials used in applications in order to reduce carbon emissions for a sustainable future.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Understand the classification and properties of different materials	**A1** Classification of materials **A2** Macroscopic properties **A3** Microscopic structure	Investigative report or presentation showing the different types of materials.
B Examine the uses, benefits and limitations of developing nanotechnology materials	**B1** Defining nanotechnology **B2** Uses of nanotechnology **B3** Benefits of nanotechnology **B4** Environmental impact and health and safety risks of nanotechnology materials	Report or presentation based on case studies, internet searches and class discussions.
C Investigate benefits and limitations of polymer technology	**C1** Polymers and their sources **C2** Benefits of polymers **C3** Limitations and environmental risks of polymers	Report or presentation based on case studies, internet searches and class discussions.
D Examine materials used in applications in order to reduce carbon emissions for a sustainable future	**D1** Wind turbine blades **D2** Solar photovoltaic cells **D3** Light-emitting diodes (LEDs) **D4** Fuel cells	Report or presentation based on case studies, internet searches and class discussions.

Content

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

Learning aim A: Understand the classification and properties of different materials

A1 Classification of materials

- Metals and alloys – ferrous and non-ferrous metals and alloys, iron and steels, noble metals (copper, silver and gold and their alloys), aluminium, rare earth metals (e.g. neodymium, dysprosium, europium, lanthanum), raw materials for green technologies (e.g. lithium, cobalt, manganese).
- Glass – soda-lime-silica glass, sodium borosilicate glass, aluminosilicate glass, oxide glass, toughened glass; glass can be coloured by adding metallic salts such as antimony oxides and copper compounds; smart glass technologies, e.g. electrochromic glass for energy-efficient buildings, damage/scratch-resistant glass used in digital devices.
- Polymers (plastics) – thermosetting plastics (urea formaldehyde, Bakelite, polyurethane), thermoplastics (polyethylene, nylon, polyvinyl chloride, polystyrene, Teflon, thermoplastic resins), advances in recyclable plastics, e.g. bioplastics, biodegradable polymers.
- Ceramics – structural, refractories, white wares, special, fine ceramics, advanced ceramics for electronics, medical implants, 3D-printed ceramics, space and aerospace applications.
- Carbon – diamond, graphite, graphene, carbon fibres, carbon nanotubes, carbon quantum dots, e.g. sensors, bioimaging.
- Composites – reinforced plastics, carbon and glass fibre composites, carbon fibre-reinforced composites, metal composites, ceramic composites, sandwich structures, concrete composites, sustainable composites, e.g. natural fibre composites, bio-based, recycled.

A2 Macroscopic properties

- Melting point, boiling point.
- Strength, toughness, malleability.
- Electrical conductivity, thermal conductivity.
- Density.
- Biodegradability.
- Digitalisation of material testing, e.g. AI-driven property prediction, real-time monitoring using Internet of Things (IoT) sensors, data-driven materials selection.

A3 Microscopic structure

- Atomic structure, bonding.
- Additives such as cross-linking agents, plasticisers.

- Reinforcing fibres/particles.
- Use of machine learning and computational modelling to predict and design microscopic structures.

Learning aim B: Examine the uses, benefits and limitations of developing nanotechnology materials [MY – TPR]

B1 Defining nanotechnology

- Nanoscale – 1 to 100 nanometres; 1 nanometre is 1×10^{-9} of a metre.
- Use of scanning tunnelling microscope (STM) and atomic force microscope (AFM).
- Manipulation and control of matter on a near-atomic size (including atoms and molecules).
- Movement of individual atoms.
- Nanotechnology materials at this size can have unique, different chemical, biological and physical properties compared with their larger counterparts at the macroscopic level.
- Researching, developing and utilising these properties is at the heart of nanotechnology.
- Types of nanoparticles defined by shape, to include nanotubes, nanowires, nanofilms, nanotunnels, nanoplates.
- AI-enabled nanomaterial discovery.

B2 Uses of nanotechnology

- Computing and instrumentation – nanoscale transistors, nanosensors, nanoelectronics.
- Energy – nanosolar panel films.
- Medicine – targeted medicine delivery, biomedical instrumentation.
- Chemotherapy nanoengineering – nanorobotics, nanoelectronics.
- Nanomachines and nanochemistry – nanosunscreens, nanocatalysts, nanocarbon tubes, graphene, nanospheres.
- Environmental remediation, e.g. water purification, food safety, carbon capture.

B3 Benefits of nanotechnology

- Improved biological, chemical and physical properties of materials, to include:
  - greater strength
  - lighter weight
  - greater chemical reactivity
  - scratch resistance
  - improved catalysis
  - improved electrical conductivity
  - antibacterial coatings.

B4 Environmental impact and health and safety risks of nanotechnology materials

- Environmental impacts e.g. effects on the respiratory system from exhaust system nanoparticles, effects on marine life through water systems from products such as cosmetics and toothpaste.
- Health and safety risks – safe use and handling risks to employees, exposure levels, high toxicity, possible lung cell damage.

Learning aim C: Investigate benefits and limitations of polymer technology

C1 Polymers and their sources

- Terminology – natural and synthetic, thermosetting and thermoplastics, polymerisation, monomer, polymer and co-polymer, polymer composites, elasticity and plasticity.
- Sources of starting materials – petroleum oil, sugars, corn starch, cellulose, hydroxycarboxylic acids, waste CO_2, algae and fungi.
- Additives to improve properties – fillers, plasticisers, cross-linking agents, impact modifiers, antioxidants, stabilisers and decolourants, green chemistry approaches to polymer synthesis.

C2 Benefits of polymers

- Improved properties compared with some conventional materials – low thermal and electrical conductivity, lightweight and easy to handle, durable and resistant to corrosion, easy to shape during manufacture, good electrical and thermal insulating properties, strong and flexible, new biodegradable plastics.
- Uses of polymers – construction, transport, electronics and computing, renewable energy (e.g. wind turbine blades, solar panels), sport and leisure, packaging, domestic household uses, smart polymers, e.g. self-healing, shape memory.

C3 Limitations and environmental risks of polymers

- Limitations – some have low strength, can be toxic and flammable, ultraviolet (UV) light sensitive, fatigue sensitive, most are not biodegradable.
- Environmental impact – global plastic waste crisis, most are not biodegradable in the short term, microplastic risks to animal and human health, some plastics cannot be recycled, high toxicity, bans on single-use plastics.

Learning aim D: Examine materials used in applications in order to reduce carbon emissions for a sustainable future

D1 Wind turbine blades

- Materials used – glass fibre composites, aluminium, bio-based composites.
- Key useful properties of materials used – high strength and stiffness, low density, durability, corrosion resistance.
- Limitations of materials used – low fatigue resistance.
- Benefits of use of wind turbines.

D2 Solar photovoltaic cells

- Materials, e.g. silicon wafer, cadmium telluride (CdTe).
- Key useful properties of materials used – CdTe responds well to light in the solar spectrum.
- Benefits and limitations of materials used – silicon is readily available, CdTe is environmentally unfriendly, tellurium is a very rare element and therefore costly.
- Benefits of solar photovoltaic cells, Perovskite solar cells, organic photovoltaics.

D3 Light-emitting diodes (LEDs)

- Materials, e.g. gallium arsenide (GaA), gallium nitride.
- Useful microscopic and macroscopic properties of materials used, e.g. electrons can travel very quickly, good conductors of thermal energy.
- Benefits and limitations of materials used – GaAs may be carcinogenic; gallium is expensive to extract.
- Applications – lighting, infrared beams, IoT, smart cities.

D4 Fuel cells

- Materials – polymers for electrolyte membranes and ceramic-based electrolytes.
- Innovations in hydrogen production (e.g. electrolysis, solar splitting), sustainable fuel cells.
- Useful properties of materials used – decomposes water into hydrogen and oxygen more readily than many other materials.
- Benefits and limitations of materials used – easily obtained, are not environmentally friendly (disposal issues), associated cost implications of damage and end-of-life removal.

Assessment criteria

Learning aim A: Understand the classification and properties of different materials

Pass	Merit	Distinction
A.P1 Determine the classification of given materials by considering their properties.	**A.M1** Compare the microscopic structures and classifications of different given materials to determine their macroscopic properties.	**A.D1** Analyse the microscopic and macroscopic structure of different materials to classify by group according to their properties.

Learning aim B: Examine the uses, benefits and limitations of developing nanotechnology materials

Pass	Merit	Distinction
B.P2 Explain the meaning of a nanotechnology material. **B.P3** Explain the uses and benefits of nanotechnology materials.	**B.M2** Discuss uses, benefits and health and safety risks of nanotechnology.	**B.D2** Evaluate uses, benefits, environmental impact and health and safety risks of using nanotechnology materials for given applications.

Learning aim C: Investigate benefits and limitations of polymer technology

Pass	Merit	Distinction
C.P4 Explain uses, benefits and limitations of polymers. **C.P5** Explain benefits of using additives to modify the properties of plastics.	**C.M3** Justify the use of additives and methods used for testing the suitability of different types of polymers for given applications.	**C.D3** Evaluate methods of testing, the uses, benefits, limitations and environmental risks of different types of polymers for given applications.

Learning aim D: Examine materials used in applications in order to reduce carbon emissions for a sustainable future

Pass	Merit	Distinction
D.P6 Explain how materials can be used to reduce carbon emissions.	**D.M4** Compare methods used to reduce carbon emissions.	**D.D4** Evaluate benefits and limitations of using materials in order to reduce carbon emissions.

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

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 a part of wider teaching and learning
√	Embedded in teaching, learning and assessment
blank	Not embedded or signposted in unit

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments. There is also further information on our website.

There is a maximum number of 3 summative assignments for this unit.

The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.M1, A.D1)

Learning aim: B (B.P2, B.P3, B.M2, B.D2)

Learning aim: C (C.P4, C.P5, C.M3, C.D3)

Learning aim: D (D.P6, D.M4, D.D4)

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- Access to laboratory equipment and materials samples for practical investigations and testing.
- Up-to-date resources, including scientific journals, databases and simulation software.
- Visual aids (diagrams, models and interactive presentations) to support conceptual understanding.
- Case studies illustrating applications in nanotechnology, polymers and sustainable materials.

Essential information for assessment decisions

Learning aim A

For distinction standard, students provide a thorough and insightful comparative analysis of a range of materials, clearly demonstrating how both microscopic structures (such as atomic arrangement, bonding, and the presence of additives or reinforcing agents) and macroscopic properties (such as strength, conductivity, density, and biodegradability) are interrelated. Evidence includes annotated diagrams, tables, or written explanations that explicitly link atomic or molecular features to the observable behaviours and classifications of materials, referencing examples from metals, polymers, ceramics, composites, carbon-based materials and smart materials. The analysis should reflect a deep understanding of how microscopic features influence real-world applications and sustainability, demonstrating the ability to evaluate and group materials according to their properties and technological relevance.

For merit standard, students provide comparative analysis, showing significant insight into how microscopic structures relate to macroscopic properties. Evidence may include annotated diagrams, tables or written explanations that link atomic or molecular features to real-world behaviours of materials. The student's work should reflect an ability to synthesise information from multiple sources and justify their comparisons with scientific reasoning.

For pass standard, students demonstrate foundational understanding by correctly identifying and categorising materials based on observable properties. Evidence may include clear, organised notes or diagrams that show how materials are grouped, with explanations that reference physical characteristics such as conductivity, density or malleability. The student's work should show logical reasoning in their choices and use appropriate terminology, indicating they can distinguish between major material types.

Learning aim B

For distinction standard, students evaluate the broader implications of nanotechnology, considering environmental, health and safety aspects in detail. Evidence may include critical essays, presentations or reports that assess the consequences of using nanotechnology materials in specific applications. The student's work should demonstrate a sophisticated understanding of the subject, integrating scientific, ethical and societal perspectives.

For merit standard, students discuss the applications, benefits and risks of nanotechnology, providing evidence through case studies, research summaries or comparative tables. Their work should reflect an ability to evaluate the impact of nanotechnology materials in various contexts, considering both technological advancements and safety considerations. The student's explanations should be balanced and supported by relevant examples.

For pass standard, students show understanding of nanotechnology by accurately describing what constitutes a nanomaterial and its scale. Evidence may include concise definitions, labelled diagrams or examples that illustrate the unique properties of materials at the nanoscale. The student's work should demonstrate clarity and accuracy in their explanations, using correct scientific language.

Learning aim C

For distinction standard, students evaluate testing methods, uses, benefits, limitations and environmental risks of polymers, producing comprehensive reports or presentations. Evidence should show critical analysis, with the student considering the lifecycle of polymers, sustainability issues and the impact of polymer technology on society and the environment.

For merit standard, students justify the use of additives and testing methods for polymers, presenting evidence through experimental results, annotated diagrams or comparative analyses. Their work should reflect a significant understanding of how additives modify polymer properties and how testing ensures suitability for specific uses.

For pass standard, students explain the uses, benefits and limitations of polymers, providing evidence through written summaries, charts or practical examples. Their work should show an ability to identify key properties and relate them to everyday applications, demonstrating basic understanding of polymer science.

Learning aim D

For distinction standard, students explain how materials are used to reduce carbon emissions, providing evidence through case studies, diagrams or written explanations. Their work should show an understanding of the role of materials in sustainable technologies and reference specific examples such as wind turbines or solar cells.

For merit standard, students compare different methods for reducing carbon emissions, presenting evidence through comparative tables, research summaries or analytical essays. Their work should demonstrate the ability to weigh the advantages and disadvantages of various approaches, using scientific reasoning.

For pass standard, students explain how materials are used to reduce carbon emissions, providing evidence through case studies, diagrams or written explanations. Their work should show an understanding of the role of materials in sustainable technologies and reference specific examples such as wind turbines or solar cells.

Links to other units

The assessment for this unit will draw upon some of the underpinning knowledge, understanding and skills covered in:

- Unit 2: Principles and Applications of Chemistry
- Unit 3: Principles and Applications of Physics
- Unit 14: Biochemical Processes and Pathways in Living Organisms
- Unit 19: Atmospheric Science and Climate Change.

 © Pearson Education Limited 2026

Unit 19: Atmospheric Science and Climate Change

Level: 3

Unit type: Internal

Guided learning hours: 60

Unit in brief

The unit explores the evolution of Earth's atmosphere, the science of climate change, and global responses to environmental challenges. Students analyse evidence, interpret data, and evaluate solutions for a sustainable future.

Unit introduction

This unit relates directly to real-world issues by equipping students with essential knowledge about the Earth's atmosphere, climate change and the major challenges facing society. Understanding atmospheric processes and human impacts supports informed citizenship and responsible decision-making. Students learn to interpret news, engage in debate and contribute to climate solutions at local and global levels.

The unit examines the origins and evolution of Earth's atmosphere, the mechanisms and evidence of atmospheric change, and strategies for mitigation and adaptation. You will study scientific theories, historical records and contemporary issues such as greenhouse gases, extreme weather and global agreements. Practical examples, case studies and assessments develop data interpretation, evidence analysis and critical thinking.

Completing this unit provides a strong foundation for further study in environmental science, geography and related fields. It builds research, analytical and problem-solving skills valued in sustainability, policy, education and industry. Students also develop the ability to communicate complex ideas clearly and make informed choices, supporting progression to higher education and environmentally focused careers.

Learning aims

In this unit, you will:

A Understand fundamental aspects of the Earth's atmosphere over time

B Examine evidence for atmospheric change related to 'greenhouse gases'

C Investigate measures to combat future climate change.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Understand fundamental aspects of the Earth's atmosphere over time	**A1** Evidence and theory of early atmosphere composition **A2** Historical changes to the atmosphere **A3** Development and understanding of present-day atmosphere composition	Report and diagrams or presentation on early atmospheric gases and elements.
B Examine evidence for atmospheric change related to 'greenhouse gases'	**B1** Evidence of atmosphere changes since the start of industrialisation **B2** Nature and causes of greenhouse gases **B3** Possible future trends of atmosphere changes and their effects	Report or presentation on greenhouse gases and their behaviour.
C Investigate measures to combat future climate change	**C1** Climate change forums **C2** Changes to industrial methods and science innovation **C3** Changes that can be made by individuals	Report or presentation on humans and climate change supported with case study.

Content

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

Learning aim A: Understand fundamental aspects of the Earth's atmosphere over time

A1 Evidence and theory of early atmosphere composition

- Development of the Earth from nebula gases and its initial surface as molten materials.
- Pre-biological life atmosphere consisting of methane, nitrogen, carbon dioxide, ammonia, carbon monoxide, water vapour and hydrogen.
- Physical evidence in ancient sedimentary rocks indicating chemical reactions and biochemical processes.
- Findings from planetary science and astrobiology, isotope analysis, AI-driven data interpretation.

A2 Historical changes to the atmosphere

- Evidence of photosynthesis approximately 3 billion years ago (3 × 109 years).
- Changes in atmosphere composition from 4.5 billion years to development of plant life.
- The Earth's crust in terms of:
  - rocks
  - oceans
  - atmosphere.
- Volatile compounds – nitrogen, oxygen, helium, argon, water, carbon dioxide, hydrogen, methane, ammonia, nitrous oxide and nitrogen dioxide, hydrogen sulphide, sulphur dioxide and hydrogen chloride.
- Sources (means of adding gas to the atmosphere) and sinks (removal of gas from the atmosphere).
- Residence time as the length of time that atmospheric molecules spend in the atmosphere.

A3 Development and understanding of present-day atmosphere composition

- Main gases and %age composition (nitrogen 78%, oxygen 21%, argon 1%, carbon dioxide 0.04% and other trace gases).
- Atmospheric layers:
  - troposphere
  - stratosphere
  - mesosphere
  - thermosphere
  - exosphere.

- Altitudes of atmospheric layers in kilometres.
- Characteristics in composition and properties of individual atmospheric layers.
- Space weather impacts, satellite monitoring.

Learning aim B: Examine evidence for atmospheric change related to 'greenhouse gases'

B1 Evidence of atmosphere changes since the start of industrialisation

- Carbon (as carbon dioxide) in the atmosphere and its change in abundance over the last 200 years.
- The 'bio-geo-chemical' cycle (carbon as the main element in biological compounds and other substances, including carbonate rocks).
- The carbon cycle and fossil fuels (oil, coal and gas).
- Carbon sinks – soil, plants and oceans.
- Influence of Milankovitch cycles.
- Graph of CO_2 levels in the atmosphere – steady peaks and troughs cycle pre-1950 (180–300 ppm), rapid increase (300 to 410 ppm) since 1950:
    - seven cycles of glacial advances and retreats in the last 800,000 years
    - changes to the orbit of the Earth having an important effect
    - effect of CO_2 and other gases on passage of infrared radiation through the atmosphere
    - evidence from ice core drilling (Greenland, Antarctica, mountain glaciers)
    - evidence from sediments in the oceans, tree rings and coral reefs.
- Increase in methane levels (84 times more heat per unit mass than CO_2).
- Temperature patterns – five of the warmest years recorded since 2010, 0.4°C increase in temperature of oceans to depth of 700 m over last 50 years.
- Loss of ice sheets and glacial retreat, loss of snow cover.
- Sea level rise by 20 cm over last 100 years.
- Increase in extreme weather events, e.g. hurricane strength and frequency, increased aridity.
- Increase in acidity of oceans.
- Melting of permafrost.

B2 Nature and causes of greenhouse gases

- Greenhouse gases:
    - carbon dioxide (volcanic eruptions, deforestation, burning of fossil fuels such as wood and coal, change of land use)
    - water vapour (rise in global temperature increases the amount of water vapour as clouds and rainfall in the atmosphere)
    - nitrous oxide (burning fossil fuels and biomass, use of organic fertilisers)

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

  - methane gas (produced from landfill sites, agriculture, ruminant digestion)
  - chlorofluorocarbons (CFCs) – synthetic compounds used in industry that also deplete ozone in the Earth's atmosphere.

B3 Possible future trends of atmosphere changes and their effects

- Rise in atmospheric levels of CO_2 and the 'greenhouse effect'.
- Variation of warm and cold areas on the Earth's surface.
- Increase in hot and cold weather extremes.
- Increase in wind speeds in general and in hurricane-force events.
- Increased sea level rise from glacial and polar ice melting.
- Artificial intelligence (AI) in climate prediction, climate models.
- Changes in plant growth owing to climate changes, including variation in growth height, changes in crop types grown in different parts of the world, and displacement of populations from low and high altitudes resulting from increased rainfall and sea level rise.

Learning aim C: Investigate measures to combat future climate change

C1 Climate change forums

- Intergovernmental Panel on Climate Change (IPCC).
- United Nations Framework Convention on Climate Change (UNFCCC).
- Key Conference of the Parties (COP) meetings, such as:
  - 1997 Kyoto Protocol
  - 2016 Paris Agreement
  - 2021 Glasgow
  - 2023 Dubai.
- Youth Climate Summit initiative.
- Intergovernmental political forums, e.g. G7.
- Confirmation of scientific data and scientific agreement.
- Agreement of scientific studies and findings in the scientific community that human activities are the main cause of current climate change.
- Climate activism.

C2 Changes to industrial methods and science innovation

- Main greenhouse gas emitters – production of electricity and heat, transport, manufacturing, agriculture.
- Renewable energies – increased use of solar panels, wind turbines, geothermal energy in suitable locations, hydroelectric power in highland areas, continued development of hydrokinetic energy (using the movement of water in rivers, tides and waves).
- Nuclear power – low carbon emissions throughout its operating lifetime, but implications of health issues and environmental damage that must be overcome.

- Increasing fuel efficiency in transportation, increased use of electric and hydrogen fuel-cell cars, buses, trains, industrial transport.
- Emerging technologies, role of AI and automation.

C3 Changes that can be made by individuals

- Reduction in personal carbon emissions: transition to electric vehicles, sharing transport (e.g. carpools, hourly car rental apps), walking/using public transport to nearby destinations, cycle lanes, recycling materials maximisation.
- Reduce consumption: recycle/repair/reuse of items, choose sustainable brands, composting.
- Energy use: energy-efficient appliances, renewable electricity supply.
- Transition to sustainable energy, e.g. heat pumps, solar roof panels.

Assessment criteria

Learning aim A: Understand fundamental aspects of the Earth's atmosphere over time

Pass	Merit	Distinction
A.P1 Explain evidence and theories related to the composition of the atmosphere.	**A.M1** Discuss differences between early and present-day atmosphere.	**A.D1** Evaluate evidence for, and understanding of, atmosphere changes over time.

Learning aim B: Examine evidence for atmospheric change related to 'greenhouse gases'

Pass	Merit	Distinction
B.P2 Describe evidence linking global warming to industrialisation. **B.P3** Describe factors that can cause greenhouse gases. **B.P4** Explain possible effects of climate change on the Earth's atmosphere.	**B.M2** Analyse evidence related to global warming and climate change. **B.M3** Explain effects of human activities on the future atmosphere.	**B.D2** Compare effects of pre- and post-industrial activities on the Earth's surface and its atmosphere.

Learning aim C: Investigate measures to combat future climate change

Pass	Merit	Distinction
C.P5 Describe how effects of climate change could be addressed.	**C.M4** Explain methods that could help to address climate change.	**C.D3** Evaluate methods used to address climate change.

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 a part of wider teaching and learning
√	Embedded in teaching, learning and assessment
blank	Not embedded or signposted in unit

 © Pearson Education Limited 2026

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments. There is also further information on our website.

There is a maximum number of 3 summative assignments for this unit.

The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.M1, A.D1)

Learning aim: B (B.P2, B.P3, B.P4, B.M2, B.M3, B.D2)

Learning aim: C (C.P5, C.M4, C.D3)

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- Up-to-date textbooks and scientific journals covering atmospheric science, climate change and mitigation strategies.
- Access to resources: climate data sets, interactive simulations and remote sensing imagery.
- Laboratory equipment for basic atmospheric experiments and demonstrations (e.g. gas sensors, model kits).
- Reliable internet connection for research, accessing climate forums, and engaging with global initiatives and case studies.

Essential information for assessment decisions

Learning aim A

For distinction standard, students demonstrate critical judgement by weighing the robustness, limitations and uncertainties of different evidence strands used to reconstruct atmospheric evolution. They synthesise across disciplines – geochemistry, paleobiology and planetary science – to explain why interpretations converge or diverge, and they justify which models best align with current consensus. Data is interrogated for quality (e.g. dating precision, contamination risk, proxy calibration), and alternative explanations are explored before reasoned conclusions are drawn. Visuals are not only accurate but purposeful, with captions that articulate methodological significance. The narrative is cohesive, connecting deep-time transitions to present atmospheric characteristics through mechanisms and feedback. Citations are selective and authoritative. Overall, the work shows independence of thought, methodological awareness, and a well-substantiated line of argument.

For merit standard, students move beyond description, using comparison to highlight how atmospheric composition and structure have changed across deep time. Evidence shows they can relate processes –volcanism, photosynthesis, chemical weathering – to observed shifts in gases and temperatures. They draw on more than one evidence type (e.g. banded iron formations alongside stromatolite records) and explain why these sources are informative. Writing is precise and uses accurate, topic-specific terminology; timelines are handled carefully to avoid anachronism. Where figures or tables are presented, the student interprets salient patterns rather than merely reproducing them. They identify links between the geosphere, hydrosphere and biosphere, demonstrating how feedbacks may amplify or dampen change. Overall, the work is analytical in tone, with reasoned statements supported by appropriate, clearly referenced examples.

For pass standard, students show secure foundational understanding by presenting key facts about atmospheric origins, major gaseous components, and broad timelines without substantive misconceptions. Evidence typically includes correctly labelled diagrams of atmospheric layers, clear definitions of core terms (e.g. outgassing, photodissociation), and brief references to how scientists infer past conditions from geological records. They select appropriate examples – such as sedimentary indicators or isotopic signatures – and state what these imply at a basic level. Explanations are largely descriptive, yet coherent, with accurate units and consistent use of scale (billions versus millions of years). Any data included is cited or linked to a credible source, even if analysis remains limited. Work is organised, with logical sequencing, and demonstrates that essential content has been grasped and communicated plainly.

Learning aim B

For distinction standard, students construct a comparative account that integrates pre-industrial baselines, industrial-era transformations, and contemporary dynamics, evaluating how human systems have reshaped atmospheric composition and surface processes. They critically appraise proxy quality, dataset harmonisation and attribution studies, explaining how confounders are controlled and why specific conclusions are warranted. Quantitative reasoning is evident: ratios, trends and uncertainty bounds are interpreted to assess strength of evidence. The student situates findings within broader Earth-system feedback (cryosphere, biosphere, oceans) and discusses differential regional impacts without overextending claims. Visual evidence is curated deliberately to support key points. The final synthesis articulates nuanced, defensible conclusions that reflect methodological rigour, interdisciplinarity and clear understanding of causal mechanisms across timescales.

For merit standard, students offer structured analysis of multiple lines of evidence, interpreting how records from different archives align to reveal causes and consequences of atmospheric change. They discuss temporal resolution and lag effects (e.g. ocean heat uptake) and interpret variability without confusing short-term fluctuations with long-term trends. Explanations make reasoned connections between sectoral activities and emissions profiles, including consideration of land-use change and non-CO_2 gases. Figures are interrogated for pattern, scale and anomaly, with succinct commentary on uncertainty ranges. The student demonstrates awareness of how measurement techniques (remote sensing, in situ sampling) complement each other. Their argumentation is balanced, acknowledging limitations while still reaching evidence-based judgements that are properly supported and clearly communicated.

For pass standard, students select relevant, recent examples that illustrate changes in greenhouse gas levels and associated climatic responses. They describe patterns in accessible datasets – such as steadily rising carbon dioxide concentrations or long-term temperature trends – and correctly identify the indicators used to detect past conditions (ice cores, tree rings, or sediment records). Explanations link human activity to observed changes using straightforward reasoning, and basic terms – radiative forcing, albedo, feedback – are used accurately. Presentation is clear and factual, with graphs or tables labelled and units stated. While commentary is mostly descriptive, it remains accurate and avoids overgeneralisation. The student's choices of evidence are appropriate to the question, conclusions are cautious, and sources are referenced, even if discussion of method reliability or confounding factors is limited.

Learning aim C

For distinction standard, students offer a well-substantiated evaluation of contrasting approaches, considering effectiveness, feasibility, distributional effects and system-wide interactions. They appraise trade-offs – cost, scalability, land and resource use, social equity – and examine risks such as rebound effects or lock-in. Evidence is integrated from diverse, reputable sources, and uncertainty is acknowledged through sensitivity or scenario discussion. The student articulates prioritisation logic, explaining why specific portfolios align with stated objectives under different constraints. Recommendations are concrete, time-bound where appropriate, and supported by transparent reasoning and relevant performance indicators. The overall judgement is balanced, analytically robust, and demonstrates an advanced understanding of how coordinated actions can accelerate climate progress.

For merit standard, students explain a coherent mix of technological, behavioural and policy measures, showing how they interact within energy, transport, buildings, industry and land-use systems. They discuss enabling factors – finance, regulation, infrastructure, skills – and identify common barriers such as upfront costs and social acceptance. Evidence includes illustrative case studies or pilots, interpreted to show transferability and context limits. The student uses appropriate metrics (emissions intensity, payback periods, capacity factors) and distinguishes near-term deployables from longer-lead innovations. Diagrams or tables clarify pathways and decision points. Overall, the account connects solutions to outcomes credibly, with reasoned explanation of why certain combinations are likely to deliver meaningful impact.

For pass standard, students identify practical responses at individual, community and institutional levels, showing how basic actions can reduce emissions or increase resilience. They accurately describe common approaches – energy efficiency, renewable uptake, active travel, waste reduction – and indicate simple co-benefits such as improved air quality or cost savings. Explanations distinguish mitigation from adaptation and place actions within relevant initiatives or forums. Examples are realistic and proportionate, with appropriate use of everyday metrics (kilowatt-hours, degrees Celsius, tonnes of waste). While evaluation is limited, the student avoids overclaiming and presents feasible steps supported by straightforward evidence or guidance. Organisation is clear, with signposting that helps the reader follow the logic from problem to solution-focused response.

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

Links to other units

The assessment for this unit will draw upon some of the underpinning knowledge, understanding and skills covered in

- Unit 7: Chemical Principles and Reaction Systems
- Unit 11: Energy Generation Challenges and Opportunities
- Unit 15: Applications of Physical, Inorganic and Organic Chemistry.

Unit 20: Human Body Systems: Regulation, Control, and Reproduction

Level: 3

Unit type: Internal

Guided learning hours: 60

Unit in brief

This unit explores the nervous, musculoskeletal, cardiovascular, respiratory and reproductive systems, focusing on their regulation and interdependence.

Unit introduction

This unit is highly relevant to real-world health and wellbeing, giving students essential knowledge of how the body maintains balance and responds to change. Understanding the nervous, musculoskeletal, cardiovascular, respiratory and reproductive systems is vital for careers in health, science or sport. Students also learn how lifestyle, environment and technology influence physiological processes and overall human functioning.

The unit explores the nervous system, the regulation of cardiovascular and respiratory function, and the mechanisms of human movement. You will study hormonal control and the structure and physiology of the reproductive system. Current scientific understanding, emerging health trends and practical applications are integrated throughout, helping you develop strong theoretical knowledge and analytical biological skills.

Completing this unit supports progression into biology, health sciences and related fields, while enhancing employability in healthcare, research and sports industries. Students develop critical thinking, problem-solving and communication skills valued by universities and employers. The unit builds scientific literacy and adaptability, preparing learners to respond effectively to new developments and challenges in health and science.

Learning aims

In this unit, you will:

A Understand the interrelationship between the nervous system and the musculoskeletal system

B Understand the interrelationship and control of human cardiovascular and respiratory systems

C Understand the role of hormones in the regulation and control of the reproductive system.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Understand the interrelationship between the nervous system and the musculoskeletal system	**A1** Nervous system organisation **A2** Musculoskeletal system **A3** Disorders of the musculoskeletal system	Concept map and report or briefing.
B Understand the interrelationship and control of human cardiovascular and respiratory systems	**B1** Structure and function of the cardiovascular and respiratory system **B2** Cardiovascular and respiratory system regulation and control **B3** Impact of an imbalance	Diagrams, briefing or presentation, case data.
C Understand the role of hormones in the regulation and control of the reproductive system	**C1** Structure and function of reproductive anatomy **C2** Reproductive processes	Visuals, cycle timeline, commentary.

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

Content

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

Learning aim A: Understand the interrelationship between the nervous system and the musculoskeletal system

A1 Nervous system organisation

- Components of the central and peripheral nervous systems.
- Parts of the CNS involved in coordinating movement including:
  - motor cortex
  - cerebellum
  - basal ganglia
  - spinal cord.
- Neuron and glial cells, to include a comparison of myelinated and unmyelinated neurons.
- Transmission of action potentials and saltatory conduction, including interpretation of graphs.
- Neurotransmitters.
- Proprioception and the role sensory receptors in musculoskeletal system that help detect position, stretch, pain, and send impulses to brain to coordinate movement.
- Roles and regulation of the autonomic nervous system divisions (sympathetic and parasympathetic), to include different neurotransmitters including acetylcholine.
- Stages in and role of voluntary and non-voluntary reflexes and reactions, to include afferent and efferent pathways and the role of interneurons.

A2 Musculoskeletal system

- Structure and function of skeleton.
- Bones:
  - osteocytes
  - collagen
  - bone marrow
  - spongy vs compact bone tissue.
- Joints:
  - fixed
  - partially movable
  - hinge
  - gliding
  - ball and socket
  - pivot.

- Synovial joints:
  - cartilage
  - synovial fluid
  - joint capsule
  - Ligaments.
- Antagonistic pairs (levers, anchorage), e.g. elbow.
- Types of muscles:
  - cardiac – non-fatiguing, involuntary
  - skeletal – fatiguing, voluntary
  - smooth – involuntary, slow contraction.
- Structure of skeletal muscles:
  - sarcomere
  - mitochondria
  - myofibril
  - actin
  - myosin.
- Skeletal muscle contraction (role of Ca^{2+}).
- Control of muscle contraction (acetylcholine, efferent pathway, motor neurons).

A3 Disorders of musculoskeletal system

- The causes and treatments of:
  - dystrophies
  - neuromuscular, e.g. motor neuron disease
  - arthritis
  - osteoporosis
  - fibromyalgia.

Learning aim B: Understand the interrelationship and control of human cardiovascular and respiratory systems

B1 Structure and function of cardiovascular and respiratory system

- Structure of heart -atria, ventricles, bicuspid valve, tricuspid valve, semi-lunar valves, septum, major blood vessels (aorta, vena cava, pulmonary artery, pulmonary vein), coronary arteries).
- Cardiac cycle with graphs showing pressure and volume.
- Medical equipment for monitoring cardiac cycle, e.g. stethoscopes, blood pressure monitors, electrocardiograms.
- Treatments- defibrillation, pacemakers, epinephrine autoinjector (EpiPen).

- Respiratory system structure and function.
- Measuring ventilation- tidal volume, ventilation rate, spirometers.

B2 Cardiovascular and respiratory system regulation and control

- How changes occur in concentrations of oxygen and carbon dioxide.
- Bohr shift and oxygen dissociation.
- Role of chemoreceptors and baroreceptors.
- Gaseous exchange at tissues and alveoli.
- Autonomic nervous system; sympathetic and parasympathetic pathways.
- Role of medulla oblongata in coordination.
- Elasticity of blood vessels related to function.
- Control of heart rate – role and action of:
    - sinoatrial and atrioventricular nodes
    - bundle of His
    - Purkinje fibres.
- Control of inspiration, expiration and rate of ventilation:
    - changes in contraction and relaxation of diaphragm and intercostal muscles
    - relative air pressure changes.
- Effects of air pollution and climate change, wearable sensors, telemedicine, AI-driven personalised medicine.

B3 Impact of an imbalance

- Conditions caused by an imbalance of a homeostatic mechanism, to include effects on:
    - normal functioning and potential management strategies, e.g. dehydration, hyperglycaemia
    - hypoglycaemia, diabetes, hypothermia, hyperthermia, syndrome of inappropriate antidiuretic hormone (SIADH).

Learning aim C: Understand the role of hormones in the regulation and control of the reproductive system

C1 Structure and function of reproductive anatomy

- Female reproductive system: ovary, fallopian tube (oviduct), uterus, uterine horn, fimbriae, endometrium, cervix, vagina, labia.
- Male reproductive system: epididymis, seminal vesicle, Cowper’s gland, prostate gland, testes, penis, scrotum, vas deferens, erectile tissue.
- Advances – e.g. reproductive technology, inclusive language, gender diversity, gender-affirming care.

C2 Reproductive processes

Stages in the following, to include the interactions of hormones (to include progesterone, oestrogen, testosterone, FSH and LH as appropriate). Timescales for each should be referenced, and links made to effects on fertility.

- Gamete development and release; infertility causes and identification in these stages:
  - oogenesis from oogonia – formation of primary, secondary and Graafian follicles
  - ovulation – formation and role of corpus luteum
  - normal/abnormal morphology of oocytes – ovulation disorders
  - spermatogenesis from spermatogonia – formation of primary and secondary
  - spermatocytes and spermatids – spermiation, role of Sertoli and Leydig cells
  - normal/abnormal morphology and abundance of sperm.
- Hormonal changes in the menstrual cycle.
- Processes leading to conception, how infertility can come about in these stages and potential treatments for assisting fertility:
  - wafting of ova through fallopian tubes, semen delivery, fertilisation (including role of acrosome in penetration of the zona pellucida), implantation
  - erectile dysfunction, antisperm antibodies, effects of menopause
  - hypo/hyperthyroidism
  - sperm donation, artificial insemination
  - in vitro fertilisation (IVF); hormone replacement therapy; induction of ovulation.
- Contraceptive methods – oral, injection and implanted use of hormones to prevent pregnancy.
- Emerging fertility treatments.

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

Assessment criteria

Learning aim A: Understand the interrelationship between the nervous system and the musculoskeletal system

Pass	Merit	Distinction
A.P1 Explain the main structures and functions of nervous and musculoskeletal systems.	**A.M1** Explain how nervous and musculoskeletal systems interact to coordinate movement, referencing specific anatomical and physiological features.	**A.D1** Analyse the interrelationship of nervous and musculoskeletal systems, in terms of sensory input and treatment effectiveness.

Learning aim B: Understand the interrelationship and control of human cardiovascular and respiratory systems

Pass	Merit	Distinction
B.P2 Explain the structure, function, and basic regulation of cardiovascular and respiratory systems.	**B.M2** Analyse regulatory mechanisms, using examples, to show system control and imbalance impacts.	**B.D2** Evaluate interrelationships of cardiovascular and respiratory systems with reference to imbalances.

Learning aim C: Understand the role of hormones in the regulation and control of the reproductive system

Pass	Merit	Distinction
C.P3 Explain the structure and function of human reproductive anatomy. **C.P4** Describe how hormones are involved in gamete development and conception.	**C.M3** Explain how the regulation of male and female reproductive systems can affect human reproductive health.	**C.D3** Evaluate how conception may be prevented and promoted.

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 a part of wider teaching and learning
√	Embedded in teaching, learning and assessment
blank	Not embedded or signposted in unit

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments. There is also further information on our website.

There is a maximum number of 3 summative assignments for this unit.

The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.M1, A.D1)

Learning aim: B (B.P2, B.M2, B.D2)

Learning aim: C (C.P3, C.P4, C.M3, C.D3)

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- Anatomical models and diagrams of the nervous, cardiovascular, respiratory and reproductive systems for visual and practical reference.
- Access to up-to-date scientific journals, textbooks and digital resources covering homeostasis, neurobiology and reproductive health.
- Laboratory equipment for physiological experiments, including sensors for monitoring heart rate, respiration and hormone levels.
- Interactive software or online platforms for simulating feedback mechanisms, hormonal regulation and system interactions.

Essential information for assessment decisions

Learning aim A

For distinction standard, students critically analyse the interplay between the systems, demonstrating advanced reasoning and evaluative skills. Their responses integrate scientific concepts, drawing on multiple sources to support their arguments. The work shows an ability to synthesise information, make informed judgements, and consider the effectiveness of different approaches. Learners present a comprehensive overview, highlighting the significance of sensory input and physiological mechanisms in maintaining health and function.

For merit standard, students provide detailed explanations that show a deeper understanding of how the systems interact. Their responses include logical connections between anatomical features and physiological processes, demonstrating the ability to compare and contrast relevant aspects. The work reflects thoughtful analysis, with examples that illustrate the complexity of coordination and control. Learners show insight into the mechanisms involved, presenting information in a coherent and well-structured manner.

For pass standard, students demonstrate a basic understanding of the organisation and function of both systems, showing clear recognition of key terms and concepts. Their explanations are straightforward and accurate, reflecting foundational knowledge. Responses show that learners can recall and describe relevant features, processes, and disorders, using appropriate terminology. The work is clear and focused, indicating that learners have grasped the essential facts and can communicate them effectively.

Learning aim B

For distinction standard, students present comprehensive, critical evaluation and synthesis of information from different sources. There is evidence of well-reasoned arguments, independent research, and insightful commentary on the interrelationship and control of the systems. Comparative analysis considers emerging technologies or research and demonstrates higher-order thinking. Evidence is original, shows depth of understanding, and addresses the implications for health and disease.

For merit standard, students provide detailed and coherent explanations that go beyond basic description. The learner should show analytical thinking, by connecting theory and practice, and using annotated diagrams, graphs or case studies to support their points. Evidence should demonstrate integration of scientific principles and the ability to discuss regulatory mechanisms and environmental impacts. The work should be well-organised, with clear reasoning and relevant examples that illustrate understanding.

For pass standard, students provide clear, accurate and complete coverage of the required content, ensuring the learner demonstrates a secure understanding of the cardiovascular and respiratory systems. Evidence may include written explanations, labelled diagrams or basic case studies. The work should be factually correct and relevant, but does not need to show depth or analysis.

Learning aim C

For distinction standard, students evaluate methods for preventing and promoting conception with a critical and analytical approach, considering the effectiveness, ethical implications, and technological advancements in reproductive health. Evidence is shown through discussion of a range of contraceptive and fertility treatments, reference to current research, and evaluation of outcomes. The student's work should demonstrate independent research, synthesis of information from multiple sources, and insightful commentary on the implications for individuals and society. The ability to consider emerging trends and challenges in reproductive health indicates achievement at the highest level.

For merit standard, students provide detailed explanations of how the regulation of male and female reproductive systems can affect reproductive health, with particular emphasis on hormonal interactions and their physiological effects. Evidence is demonstrated through annotated diagrams, timelines or case studies that illustrate the impact of hormonal changes on fertility and reproductive processes. The student's work should reflect an ability to interpret and apply scientific knowledge to real-world scenarios, considering factors such as age, health status and environmental influences. The inclusion of recent advances in reproductive health or technology further supports achievement at this level.

For pass standard, students demonstrate a secure understanding of the structure and function of human reproductive anatomy by accurately identifying and describing key anatomical features and their roles. Evidence is shown through the use of clear diagrams, structured explanations and appropriate terminology. The student's work should present information in a logical sequence, making connections between anatomical structures and their physiological functions. The ability to communicate these concepts clearly and relate them to the broader context of human reproduction indicates achievement at this level.

Links to other units

The assessment for this unit will draw upon some of the underpinning knowledge, understanding and skills covered in:

- Unit 6: Health Challenges and Medical Innovations
- Unit 13: Human Disease, Infection and Environmental Health
- Unit 16: Human Body Systems: Physiology, Disorders and Health Solutions.

Unit 21: Genetics and Biotechnology Principles, Techniques and Applications

Level: 3

Unit type: Internal

Guided learning hours: 60

Unit in brief

This unit explores the structure and function of nucleic acids, cell division, inheritance and genetic engineering. Students gain practical and theoretical skills essential for understanding genetics and biotechnology in modern science.

Unit introduction

This unit develops essential understanding of genetics, molecular biology and biotechnology, which underpin advances in medicine, agriculture and forensics. Learning about nucleic acids, inheritance and genetic engineering helps students understand how genetic information shapes organisms and influences health, disease and biodiversity. As society faces genetic disorders, personalised medicine and ethical dilemmas, this knowledge supports informed decision-making.

The unit covers DNA and RNA structure and function, the genetic code and protein synthesis. You will study mitosis and meiosis to explore how variation arises, and investigate inheritance using Punnett squares, ratios and statistical methods. Practical skills include DNA extraction, PCR, gel electrophoresis and applications of genetic engineering in medicine and industry.

Completing this unit provides a solid foundation for further study in biology, genetics, biomedical sciences and related fields. Students develop analytical, practical and problem-solving abilities, alongside awareness of ethical and societal issues, supporting careers in healthcare, research, biotechnology and pharmaceuticals.

Learning aims

In this unit, you will:

A Understand the structure and function of nucleic acids in order to describe gene expression and the process of protein synthesis

B Explore how the process of cell division in eukaryotic cells contributes to genetic variation

C Explore the principles of inheritance and their application in predicting genetic traits

D Explore basic DNA techniques and the use of genetic engineering technologies.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Understand the structure and function of nucleic acids in order to describe gene expression and the process of protein synthesis	**A1** Nucleic acids **A2** The basis of the genetic code **A3** Protein synthesis	Portfolio including photographic evidence and diagrams.
B Explore how the process of cell division in eukaryotic cells contributes to genetic variation	**B1** Human chromosomes **B2** Cell division and its role in variation **B3** Practical slide preparation of dividing cells	Portfolio including photographic evidence and diagrams.
C Explore the principles of inheritance and their application in predicting genetic traits	**C1** Principles of classical genetics **C2** Further genetics	Report on inheritance and genetic traits.
D Explore basic DNA techniques and the use of genetic engineering technologies	**D1** DNA extraction **D2** Gel electrophoresis **D3** DNA amplification **D4** Transformation of cells **D5** Uses and issues of genetic engineering	Report on DNA and genetic engineering.

 © Pearson Education Limited 2026

Content

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

Learning aim A: Understand the structure and function of nucleic acids in order to describe gene expression and the process of protein synthesis

A1 Nucleic acids

- Nucleotide structure, function and location of the following:
  - DNA, to include stages and enzymes involved in DNA replication
  - RNA, to include mRNA, tRNA, rRNA, siRNA, microRNA and their roles in gene regulation and epigenetics.

A2 The basis of the genetic code

- Definitions of the following and their importance in gene expression:
  - triplet codes
  - codon
  - anticodon
  - degenerate code
  - non-overlapping.

A3 Protein synthesis

- Major stages involved in each stage (including location) and the effect of mutations on the end products, including gene editing.
- Transcription, to include introns, exons and splicing.
- Amino acid activation.
- Translation.
- Mutagenic agents (e.g. irradiation, chemical mutagens), environmental influences, e.g. microplastics, endocrine disrupters.
- Types of genetic mutations – missense, nonsense, silent, insertion, deletion, duplication, frameshift.

Learning aim B: Explore how the process of cell division in eukaryotic cells contributes to genetic variation

B1 Human chromosomes

The formation and structure of chromosomes, linked to their function:

- Centromere.
- Chromatids.
- Autosomes.
- Sex chromosomes.

- Chromosome number and karyotyping.
- Homologous and non-homologous chromosomes.

B2 Cell division and its role in variation

- Stages of the cell cycle, to include cellular activities at each stage and the checkpoints involved in progressing from one stage to the next. Students should be able to identify the stage a cell is in from given micrographs, specimens or simulations, describe the position of chromosomes and the events that take place within each stage of cell division.
- The cell cycle: G1, S phase, G2, division cytokinesis.
- The stages of mitosis, to include the similarities and differences between mitosis in animal and plant cells (interphase, prophase, metaphase, anaphase, telophase), cell cycle dysregulation in cancer and role of targeted therapies.
- The stages of meiosis in the production of gametes, including:
  - interphase, prophase I, metaphase I, anaphase I, telophase I, cytokinesis, interkinesis, prophase II, metaphase II, anaphase II, telophase II, cytokinesis
  - advances in assisted reproductive technologies (ART).
- The role of centrioles (microtubule-organising centre).
- Haploid, diploid.
- Sex determination.

B3 Practical slide preparation of dividing cells

- Equipment and techniques involved in the preparation of slides for examination using light microscopy.
- Mitosis, e.g. root tip squash.
- Meiosis, e.g. lily anther squash.

Learning aim C: Explore the principles of inheritance and their application in predicting genetic traits [MY – TPR]

C1 Principles of classical genetics

- Inheritance of straightforward phenotypic traits in animals and plants (their predicted proportions and statistical analysis of phenotypic outcomes), including polygenic traits and influence of epigenetics.
- The differences and complexities involved in continuous and discontinuous variation.
- Mendel's laws of inheritance: segregation and independent assortment.
- Practical investigation of mono and dihybrid phenotypic ratios.
- Use of Punnett squares and other genetic diagrams, to include use of the terms: allele, genotype, phenotype, heterozygous, homozygous, carrier, affected/sufferer, non-affected/non-sufferer.
- Interpretation of Mendelian ratios from practical investigations.
- Chi-squared test, probability modelling.

C2 Further genetics

- Description of genetic interaction, phenotypic traits and reasoned prediction of inheritance of the following:
  - single-gene disorders, e.g. Huntington's disease, sickle cell anaemia, sickle cell anaemia
  - incomplete dominance/blending (e.g. Tay-Sachs disease) and co-dominance, e.g. blood groups
  - sex linkage, e.g. colour blindness, haemophilia
  - chromosome mutation, e.g. Down's syndrome, Turner syndrome
  - epistasis, e.g. albinism
  - uses of gene therapy, precision medicine in treatments, non-invasive prenatal testing (NIPT).

Learning aim D: Explore basic DNA techniques and the use of genetic engineering technologies

Principles and practical application (where appropriate)/simulation of the techniques, equipment and consumables in each of the following:

D1 DNA extraction

- Genomic and plasmid DNA extraction.
- Automation, high-throughput sequencing techniques.

D2 Gel electrophoresis

- Use of restriction enzymes.
- Principles of electrophoresis.

D3 DNA amplification

- Polymerase chain reaction (PCR), digital PCR.
- Purpose of utilising PCR to amplify DNA:
  - DNA fingerprinting
  - cancer diagnosis
  - tissue typing
  - preimplantation genetic diagnosis/screening
  - infectious disease detection.

D4 Transformation of cells

- Use of vectors.
- Plasmids.
- Use of marker genes.
- DNA ligase.
- Screening to identify transformed cells.

D5 Uses and issues of genetic engineering

- Genetically modified (GM) crops, gene editing for crop resistance.
- Diagnostic tests and gene therapy, CAR T-cell therapy for cancer.
- Pharming, synthetic biology.
- Genetic screening, including preimplantation genetic diagnosis (PGD), direct-to-consumer genetic testing.
- Stem cell therapies, e.g. Parkinson's disease, macular degeneration, spinal cord injuries.
- Advances in organoid technology.
- Xenotransplantation.

 © Pearson Education Limited 2026

Assessment criteria

Learning aim A: Understand the structure and function of nucleic acids in order to describe gene expression and the process of protein synthesis

Pass	Merit	Distinction
A.P1 Explain the structure and function of DNA and various nucleic acids.	**A.M1** Discuss the functional role of nucleic acids in DNA in the stages of protein synthesis.	**A.D1** Assess the impact of error in the stages of protein synthesis.

Learning aim B: Explore how the process of cell division in eukaryotic cells contributes to genetic variation

Pass	Merit	Distinction
B.P2 Use microscopy to observe and draw the stages of mitosis and meiosis. **B.P3** Explain the structure and function of human chromosomes.	**B.M2** Discuss the behaviour of the chromosomes during the cell cycle stages of mitosis and meiosis.	**B.D2** Evaluate how the behaviour of the chromosomes leads to variation.

Learning aim C: Explore the principles of inheritance and their application in predicting genetic traits

Pass	Merit	Distinction
C.P4 Collect and record data for mono and dihybrid phenotypic ratios. **C.P5** Explain genetic crosses between non-affected, affected and carriers of genetic conditions.	**C.M3** Analyse data to explain the correlation between observed patterns of monohybrid and dihybrid inheritance. **C.M4** Apply Mendel's laws of inheritance to the results of genetic crosses.	**C.D3** Make valid predictions on patterns of monohybrid and dihybrid inheritance and variation using principles of inheritance.

Learning aim D: Explore basic DNA techniques and the use of genetic engineering technologies

Pass	Merit	Distinction
D.P6 Extract, separate and amplify DNA. **D.P7** Explain the use of genetic engineering technologies in industry and medicine.	**D.M5** Analyse the uses and implications of genetic engineering technologies in industry and medicine.	**D.D4** Make valid predictions on patterns of monohybrid and dihybrid inheritance and variation using principles of inheritance.

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 a part of wider teaching and learning
√	Embedded in teaching, learning and assessment
blank	Not embedded or signposted in unit

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments. There is also further information on our website.

There is a maximum number of 3 summative assignments for this unit.

The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.M1, A.D1)

Learning aim: B (B.P2, B.P3, B.M2, B.D2)

Learning aim: C (C.P4, C.P5, C.M3, C.M4, C.D3)

Learning aim: D (D.P6, D.P7, D.M5, D.D4)

 © Pearson Education Limited 2026

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- Light microscopes, prepared slides, and staining kits for observing cell division and chromosome structure.
- Molecular biology kits and reagents for DNA extraction, PCR amplification and gel electrophoresis, including access to basic laboratory equipment.
- Interactive genetic diagrams, Punnett squares and statistical analysis tools for inheritance investigations and data interpretation.

Essential information for assessment decisions

Learning aim A

For distinction standard, students critically evaluate the impact of errors in the stages of protein synthesis, demonstrating advanced understanding of molecular biology. Evidence includes assessment of how mutations or disruptions at various stages can affect gene expression and protein function. The student's work integrates examples of mutagenic agents and discusses the consequences of specific mutations, such as frameshift or nonsense mutations, on cellular processes. Their analysis is supported by references to current research or case studies, showing the ability to synthesise information and draw reasoned conclusions about the biological and potential clinical implications. The student's work reflects a sophisticated approach to evaluating the significance of molecular errors in health and disease.

For merit standard, students provide a comprehensive and detailed account of the functional roles of nucleic acids in the stages of protein synthesis. Evidence includes thoughtful discussion of how DNA and RNA interact during gene expression, with examples illustrating the importance of processes such as splicing and amino acid activation. The student demonstrates analytical skills by connecting molecular structure to biological function and explaining the significance of each stage. Their work may include annotated diagrams, comparative tables or flowcharts, showing a deeper understanding of the mechanisms involved. The student's explanations are supported by scientific reasoning and demonstrate an ability to synthesise information from multiple sources.

For pass standard, students demonstrate knowledge of the fundamental concepts by describing the structure and function of DNA and various nucleic acids. Evidence is shown through accurate identification of nucleotide components, their arrangement, and their roles in cellular processes. The student's work includes clear explanations of DNA replication and transcription, with correct terminology and logical sequencing. Diagrams or written accounts are presented in a way that shows the student can distinguish between types of nucleic acids and their cellular locations. The student's responses reflect an ability to recall and communicate essential facts, providing a solid foundation for further study in molecular biology.

Learning aim B

For distinction standard, students evaluate how chromosome behaviour contributes to genetic variation, demonstrating a sophisticated understanding of cell division. Evidence includes critical analysis of mechanisms such as crossing over, independent assortment and errors in segregation. The student's work explores the implications of these processes for genetic diversity and inheritance, integrating examples from research or clinical practice. Their evaluation considers both normal and abnormal outcomes, such as aneuploidy, and discusses the broader significance for evolution and human health. The student's responses reflect an ability to synthesise complex information and draw insightful conclusions about the impact of cell division on genetic variation.

For merit standard, students discuss the behaviour of chromosomes throughout the cell cycle, providing detailed explanations of the events occurring at each stage. Evidence includes analysis of how chromosomes move and change during mitosis and meiosis, with reference to checkpoints and regulatory mechanisms. The student's work demonstrates the ability to compare and contrast cell division in different cell types and to interpret micrographs or experimental data. Their explanations are supported by scientific reasoning and may include references to genetic variation resulting from these processes. The student's work reflects a deeper understanding of the complexities of cell division and its role in generating diversity.

For pass standard, students provide accurate observations and representations of the stages of mitosis and meiosis, using microscopy or diagrams. Evidence includes labelled drawings or descriptions that correctly identify key features such as chromosome alignment and separation. The student explains the basic structure and function of human chromosomes, demonstrating understanding of terms like centromere, chromatid and karyotype. Their work shows the ability to follow practical procedures and record findings in a clear and organised manner. The student's responses reflect a secure understanding of the fundamental processes involved in cell division and their relevance to genetic variation.

Learning aim C

For distinction standard, students make valid predictions about inheritance and variation, demonstrating advanced understanding of genetic principles. Evidence includes synthesis of information from multiple sources, integration of complex genetic interactions (e.g. epistasis, incomplete dominance), and consideration of environmental or epigenetic influences. The student's work includes reasoned predictions supported by scientific literature or case studies, and may address ethical or societal implications of genetic testing and screening. The student's responses reflect a sophisticated approach to evaluating genetic inheritance, with the ability to draw insightful conclusions and consider broader impacts.

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

For merit standard, students analyse data to explain observed patterns of inheritance, demonstrating the ability to interpret results and identify correlations. Evidence includes thoughtful discussion of Mendelian ratios, continuous and discontinuous variation, and the application of statistical tests such as the chi-squared test. The student applies Mendel's laws to genetic crosses, providing reasoned explanations for deviations from expected outcomes. Accurate calculations and clear presentation of findings support their analysis. The student's work reflects a deeper understanding of the complexities of inheritance and the ability to use scientific reasoning to interpret genetic data.

For pass standard, students collect and record data on monohybrid and dihybrid crosses, demonstrating the ability to follow experimental protocols and accurately document results. Evidence includes clear presentation of genetic diagrams, Punnett squares and phenotypic ratios. The student explains genetic crosses involving affected, non-affected and carrier individuals, showing understanding of basic inheritance patterns and terminology. Their work is methodical and demonstrates attention to detail in data collection and interpretation. The student's responses reflect a secure grasp of the principles of classical genetics and the ability to apply these concepts in practical investigations.

Learning aim D

For distinction standard, students make valid predictions about the future impact of genetic engineering, demonstrating critical thinking and awareness of emerging trends. Evidence includes evaluation of ethical, legal and social implications, consideration of data privacy and equity, and integration of recent advances such as synthetic biology. The student's work is informed by current research and includes reasoned arguments about the potential benefits and risks of genetic technologies. Their responses reflect a sophisticated understanding of the broader context of genetic engineering and the ability to anticipate future developments and challenges.

For merit standard, students analyse the applications of genetic engineering technologies, providing detailed explanations of their use in various contexts. Evidence includes discussion of techniques such as PCR, transformation and gene therapy, with examples from industry and medicine. The student's work demonstrates the ability to evaluate the effectiveness and limitations of these technologies, supported by scientific reasoning and reference to current practices. Their analysis may include consideration of recent advances and the impact of these technologies on society. The student's responses reflect a deeper understanding of the role of genetic engineering in modern science.

For pass standard, students demonstrate practical competence in extracting, separating, and amplifying DNA, following established protocols and using appropriate equipment. Evidence includes accurate records of procedures, observations and results, such as gel electrophoresis images or PCR data. The student explains the basic uses of genetic engineering technologies in industry and medicine, showing an understanding of key concepts and terminology. Their work is organised and demonstrates the ability to carry out laboratory techniques safely and effectively, providing a solid foundation for further study in biotechnology.

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

Links to other units

The assessment for this unit will draw upon some of the underpinning knowledge, understanding and skills covered in:

- Unit 1: Principles and Applications of Biology
- Unit 6: Health Challenges and Medical Innovations
- Unit 13: Human Disease, Infection and Environmental Health
- Unit 16: Human Body Systems: Physiology, Disorders and Health Solutions
- Unit 20: Human Body Systems: Regulation, Control and Reproduction.

 © Pearson Education Limited 2026

Unit 22: Environmental Pollution and Sustainable Waste Management

Level: 3

Unit type: Internal

Guided learning hours: 60

Unit in brief

This unit explores the sources and impacts of pollution, the effects on living organisms, and modern waste management methods.

Unit introduction

This unit develops essential understanding of pollution, its sources and its impacts on ecosystems and human health. As environmental issues such as climate change, biodiversity loss and waste management grow increasingly urgent, students must understand pollution's complexity. This knowledge supports informed decision-making, sustainable practice and meaningful engagement in environmental debates and policy discussions.

The unit examines polluting substances and their effects on air, water and land, as well as consequences for plants and animals. You will explore historic and emerging pollution issues using data, examples and case studies. The curriculum also reviews current and future waste-management strategies, encouraging progression from basic explanation to deeper analysis and critical evaluation.

Completing this unit provides a strong foundation for further study in environmental science, geography and related fields. The skills gained-research, analysis and problem solving-transfer directly to higher education and careers in environmental consultancy, policy and sustainability-focused industries. Students develop environmental awareness and responsible decision-making valued across modern workplaces.

Learning aims

In this unit, you will:

A Investigate pollution contributing factors

B Explore the effects of pollution on flora and fauna

C Investigate methods of waste management.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Investigate pollution contributing factors	**A1** Polluting substances and their sources **A2** Facts and figures relating to pollution of water, land and atmosphere	Report, presentation or research article.
B Explore the effects of pollution on flora and fauna	**B1** Evidence of pollution effects on the animal kingdom **B2** Evidence of pollution effects on the plant kingdom	Report, presentation or research article.
C Investigate methods of waste management	**C1** Current methods of managing waste **C2** Future waste-management proposals and technological developments	Report, presentation or article.

Content

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

Learning aim A: Investigate pollution contributing factors

A1 Polluting substances and their sources

- Definition of pollution as 'the introduction or presence of a substance in the environment that is harmful or poisonous', digital pollution, e.g. electronic equipment waste, data centre emissions.
- Main forms of pollution – pollutants that change the physical form of the environment (in water, in soil, in air, radioactivity, microplastics, litter, thermal pollution) and pollutants that affect the environment and which are difficult to measure (noise, light, other visual pollution, e.g. buildings).
- Water-pollutant sources – industrial waste, effluent, agriculture, oil industry, underground mining, urban runoff, electronic waste leachate, pharmaceutical/personal care products, microplastics, other chemical waste, water transportation (pleasure boating and cruises, fishing industry, cargo and oil tankers).
- Water pollution and effects on oceans and seas, rivers and streams, reservoirs, household piping and storage of potable water in developing countries.
- Air-pollutant sources – industrial gases (chemical manufacturing, steel production, fashion industry, lead smelting, dye industry, tanneries), exhaust gases from transport (road traffic, air traffic, shipping and rail), cryptocurrency mining, wildlife smoke, indoor pollution from materials.
- Air pollution and effect on human and animal health (nitrogen dioxide, sulphur dioxide and ozone are lung irritants; particulates cause lung inflammation and worsening of lung and heart disease; carbon monoxide prevents oxygen uptake by the blood; increase in asthma cases), climate and weather.
- Land-pollutant sources – agricultural activities (use of agrochemicals, pesticides, herbicides, fertilisers for farming), deforestation and subsequent soil erosion, mining and extraction (e.g. lithium/cobalt mining for batteries), development of industrial complexes, construction and urbanisation, sewage, landfill, nuclear waste, fly tipping, electronic waste dumping.
- Land pollution and effects on soil quality; soil erosion; changes in the water cycle following deforestation; climate patterns; human health (toxicity levels, air pollution, and transmission of disease); effects on wildlife and plant life (damage to ecosystems, displacement, and death of species); reduction in the tourism industry.

A2 Facts and figures relating to pollution of water, land and atmosphere

- Main activities responsible for carbon emissions:
  - production of electricity and heat combined
  - industry and manufacturing
  - agriculture
  - regular changes of land use
  - general waste.
- Quantities of various forms of pollution entering the environment annually and their effects in terms of:
  - tonnes of litter entering the oceans
  - percentage of waste from industrialising countries left in the environment without treatment
  - number of human deaths attributable to drinking unclean fresh water
  - number of seabirds and mammals killed due to microplastic waste
  - prediction models
  - projected increase in the number of motor vehicles in use
  - area of rainforest cut down
  - estimated rise in number of cases of heart disease, respiratory disease and cancer as a result of air pollution.

Learning aim B: Explore the effects of pollution on flora and fauna

B1 Evidence of pollution effects on the animal kingdom

- Historic use of pesticides, e.g. neonicotinoids, glyphosate, effects on pollinators and biodiversity.
- Oil spills – effects of shipping, large oil platforms, spills at sea and effects on seabirds, fish and mammals, role of drones and artificial intelligence (AI) in spill detection and response.
- Acid rain – caused by combustion of fossil fuels and vehicles, releasing sulphur and nitrogen into the atmosphere; effects on aquatic organisms (less tolerant to lowered pH) and soil.
- Mining for metals and metal refining – increased levels of toxic metals in the air and water ecosystems.
- Microplastics/nanoplastics – effects on marine food chains, health impacts.
- Coral reefs – process of dissolving calcium carbonate ($CaCO_3$) by acid, damage caused by increase in acidity of oceans and ocean heatwaves causing ‘bleaching’, land development, plastics, e.g. Great Barrier Reef, Florida Reef.

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

- Light pollution – LED and urban lighting and effects on wildlife, e.g. migration patterns, insect populations.
- Changes in growth and physiology of animals in the presence of long-term pollutants.
- Animal adaptation to habitat change, e.g. the purple sea urchin.
- Immediate and long-term changes to food chains and food webs.
- Increase in number of asthma and bronchitis cases in humans from increasing levels of sulphur dioxide in the air.

B2 Evidence of pollution effects on the plant kingdom

- Plants are affected in different ways by the introduction of pollutants:
  - air pollution – effects shown on leaves and stems such as chlorosis (change in colour of leaves); restricted or stunted plant growth; plant stem tissue damage; increased ozone in the lower atmosphere, reducing a plant's ability to photosynthesise; holes in the ozone layer in the upper atmosphere, resulting in excess ultraviolet light, which damages plants
  - water pollution – sources include sewage treatment, runoff and inappropriate drainage into waterways, and excess nutrients (resulting in eutrophication and algal blooms); excess chemicals discharged by industries; changes in the pH of the water by chemical discharge, damaging or killing plant life
  - land pollution – reduction in organic compounds of aluminium; direct damage to plants and leaf damage, resulting in reduced photosynthesis; increased dissolving of essential nutrients; complex chemical changes in the soil, resulting in lack of nutrients and slow plant growth; reduced soil bacteria that break down the soil into nutrients; damage to leaf stomata which reduces photosynthesis; low plant recovery rates once damaged).
- Biodiversity loss rates.
- Benefits of plants in urban areas.

Learning aim C: Investigate methods of waste management

C1 Current methods of managing waste

- Waste management – the actions performed to manage waste materials from beginning to end disposal point (collection – transportation – treatment – disposal – monitoring – continued regulation and updating of the waste process).
- Reasons for regulated waste management – prevention of air, water and land contamination, protection of population health.
- Sources of solid waste – industry, residential, commercial.
- Common categories of material waste – paper, metals, glass, plastics, organic, composites.
- Hazardous categories of waste – toxic/non-toxic, flammable, radioactive, infectious.

- Effective waste management process: waste generated – initial processing and organising waste – waste collection – separation of re-usable/recyclable waste – transport of disposable waste to landfill.
- Relative annual amounts of waste generated per person – top 10 countries.
- Case study: plastics as packaging (low cost, hydrophobic, bio-inert, easy moulding, high modulus), packaging film (impermeable to moisture and gas), expanded polystyrene (good thermal insulation), plastics as a threat to food chains (plastic bags in the oceans and effect on marine life, microplastics – less than 5 mm entering the food chain, problems with increased use of 'biodegradable' and 'bioplastics').
- Wastewater treatment:
  - biological, chemical and physical processes combine to treat wastewater and sewage effluent, which is returned to the water cycle
  - 3-stage treatment:
    - primary (sewage put in a large holding basin for macrobiotic and other components settle according to their mass, solid matter pumped out for further treatment)
    - secondary (aerobic treatment using pumps to encourage bacterial and other microorganisms to consume the organic matter)
    - tertiary (chemical feed stations sanitise the water to 99% purity and discharge back to the environment through local waterways)
  - advanced treatment technologies, e.g. membrane bioreactors, AI-driven monitoring.

C2 Future waste management proposals and technological developments

- Waste hierarchy – 'reduce, reuse, recycle' principle, suggested for the population to help develop a more sustainable future:
  - reduce the need to: buy more than one item that performs the same job; add extra to an item that does not need it; purchase an item you may never use
  - reuse items that can be used more than once and identify them clearly: in the home (e.g. reusing screws, string and jars); on a large scale (e.g. reuse of large, metal, shipping containers for building homes and offices); old clothes; rechargeable batteries; Site Waste Management Plans
  - recycle items that can be used more than once for the same or different purpose (e.g. plastics, glass bottles); buy products that have already been recycled
  - 'refuse' and 'rethink' as additional steps.
- Landfill sites (better management of waste deposits and landfill sites to increase the sorting methods for recycling, reduce the amount of waste material buried, position landfill sites away from residential areas).

- Reduction in use of pesticides and fertilisers in agriculture – sustained use of organic farming methods, regenerative agriculture and vertical farming, as cultural changes to viewing crops and livestock in more holistic systems to:
    - reduce pollution
    - protect the environment
    - reduce soil erosion and footprint
    - improve soil fertility by using sustainable biological activity
    - provide a high level of care for livestock
    - use renewable resources where possible.
- New technology and ideas:
    - advanced thermal treatment (ATT) – use of pyrolysis and gasification to change waste products chemically, producing gas fuel
    - blockchain for waste tracking
    - digital tracking waste streams using Internet of Things (IoT)
    - advancement in waste-product identification and selection by computerised machines
        - electronic methods to charge consumers for the amount of waste they produce
        - increase responsibility on retailers and fast-food outlets for disposal of waste materials.

Assessment criteria

Learning aim A: Investigate pollution contributing factors

Pass	Merit	Distinction
A.P1 Identify the main sources of pollution. **A.P2** Explain the main activities responsible for carbon emissions.	**A.M1** Analyse effects of pollution in air, water and on land.	**A.D1** Evaluate effects of pollution for a selected source.

Learning aim B: Explore the effects of pollution on flora and fauna

Pass	Merit	Distinction
B.P3 Explain evidence relating to pollution effects on plant life. **B.P4** Explain evidence relating to pollution effects on animals.	**B.M2** Analyse effects of pollution on a selected plant and wild animal species.	**B.D2** Evaluate the effects of pollution on a selected plant and wild animal species.

Learning aim C: Investigate methods of waste management

Pass	Merit	Distinction
C.P5 Explain different methods of managing waste. **C.P6** Explain a proposal for managing waste in the future.	**C.M3** Analyse a selected method of waste management.	**C.D3** Evaluate a selected method of waste management.

Issue 1 – March 2026 © Pearson Education Limited 2026

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 a part of wider teaching and learning
√	Embedded in teaching, learning and assessment
blank	Not embedded or signposted in unit

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments. There is also further information on our website.

There is a maximum number of 3 summative assignments for this unit.

The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aim: B (B.P3, B.P4, B.M2, B.D2)

Learning aim: C (C.P5, C.P6, C.M3, C.D3)

Issue 1 – March 2026 © Pearson Education Limited 2026

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- Access to scientific journals, case studies, and current news articles on emerging environmental issues.
- Laboratory equipment and materials for practical investigations into pollution and waste processes.
- Interactive tools, such as data analysis software, simulation platforms and multimedia for visualising environmental changes.

Essential information for assessment decisions

Learning aim A

For distinction standard, students provide a comprehensive and critical evaluation of the effects of pollution from a selected source, integrating a wide range of evidence and perspectives. Their work demonstrates advanced reasoning, weighing the relative impacts and considering broader implications such as policy, health, sustainability and emerging global challenges. Evidence includes synthesis of data, case studies and current research, with clear justification for their conclusions. The student's evaluation is nuanced and insightful, reflecting awareness of the complexity of environmental issues and the interplay between social, economic and scientific factors. Their work may propose solutions, critique existing approaches, and demonstrate an understanding of new and emerging themes in pollution management, showing a high level of independent thought.

For merit standard, students' work demonstrates a more developed understanding by analysing the effects of pollution across air, water and land environments. Evidence includes thoughtful discussion of how pollutants impact ecosystems, human health and climate, often supported by data, case studies or scientific research. The student is able to compare and contrast different forms of pollution, considering both immediate and long-term consequences. Their analysis is logical and well-structured, showing an ability to interpret information and draw reasoned conclusions about the significance of pollution. The student's work may include graphical representations, statistics or references to current events, demonstrating a capacity to synthesise information from multiple sources and present a balanced view of the topic.

For pass standard, students demonstrate a secure grasp of the fundamental concepts by clearly identifying and describing the main sources and activities responsible for pollution. Their evidence typically consists of concise explanations supported by relevant examples, such as industrial, agricultural and domestic sources. The student's work shows an ability to distinguish between different types of pollution and their origins, referencing appropriate facts and data. While their explanations are accurate and relevant, they may be largely descriptive, focusing on straightforward links between human activity and environmental impact. The student's evidence is well-organised and factual, demonstrating an ability to reliably recall and communicate essential information about pollution without significant errors or omissions, but may not yet show deeper analysis or critical thinking.

Learning aim B

For distinction standard, students' evaluation is thorough and insightful, considering the full range of effects of pollution on selected plant and wild animal species. Evidence includes critical appraisal of scientific research, integration of multiple sources, and consideration of emerging threats such as climate change, microplastics or invasive species. The student demonstrates advanced reasoning, weighing the significance of impacts and proposing informed conclusions about the long-term implications for biodiversity and ecosystem health. Their work may include discussions of conservation strategies, policy developments and innovative solutions, reflecting a sophisticated understanding of the challenges and opportunities in managing the effects of pollution on flora and fauna.

For merit standard, students analyse effects of pollution on selected plant and wild animal species in greater depth, demonstrating a strong grasp of ecological principles. Evidence includes detailed discussion of physiological, ecological and behavioural changes, supported by scientific data or case studies. The student interprets evidence, compares impacts across species, and considers both direct and indirect effects, such as changes to food chains or habitat loss. Their work reflects an understanding of the interconnectedness of ecosystems and the broader consequences of pollution, often referencing current research or global trends. The student's analysis is logical and well-supported, showing an ability to synthesise information and present a balanced view.

For pass standard, students provide clear and accurate explanations of how pollution affects plant and animal life, referencing specific examples and evidence. Their work demonstrates an understanding of the mechanisms by which pollutants cause harm, such as changes in growth, physiology or population numbers. Evidence may include descriptions of historic and current cases, showing that the student can relate pollution to observable impacts on living organisms. The student's explanations are factual and relevant, focusing on the direct effects of pollutants on flora and fauna. Their work is well-organised and demonstrates the ability to communicate essential information, but may not explore the topic in depth or consider wider ecological implications.

Pearson BTEC International Level 3 Qualifications in Applied Science – Issue 1 – March 2026 © Pearson Education Limited 2026

Learning aim C

For distinction standard, students evaluate a selected method of waste management, integrating evidence from research, policy and technological developments. Their work demonstrates critical thinking, considering factors such as sustainability, innovation and future trends. Evidence includes appraisal of new and emerging technologies, discussion of global best practices, and reflection on the challenges of implementation. The student's evaluation is comprehensive, showing awareness of the complexities and opportunities in modern waste management. Their work may propose solutions, critique existing approaches, and demonstrate an understanding of the role of policy, technology and public engagement in achieving sustainable waste management outcomes.

For merit standard, students analyse a selected method of waste management, discussing its effectiveness and limitations in detail. Evidence includes comparison with alternative approaches, consideration of environmental and social impacts, and use of relevant data or case studies. The student interprets information, assesses outcomes, and draws reasoned conclusions about the suitability of different methods in various contexts. Their work may reference technological developments, policy changes, or global best practices, demonstrating a capacity to synthesise information from multiple sources. The analysis is logical and well-supported, showing an ability to evaluate the strengths and weaknesses of different waste management strategies.

For pass standard, students explain different methods of managing waste, providing accurate descriptions of processes such as collection, treatment and disposal. Evidence includes identification of key stages and technologies, with examples drawn from current practice. The student's work shows understanding of the reasons for regulated waste management and the basic principles involved, such as protecting human health and the environment. Their explanations are clear and factual, focusing on established methods and procedures. The student's evidence is well-organised and demonstrates the ability to communicate essential information, but may not explore the topic in depth or consider innovative approaches or future trends.

Links to other units

The assessment for this unit will draw upon some of the underpinning knowledge, understanding and skills covered in

- Unit 7: Chemical Principles and Reaction Systems
- Unit 15: Applications of Physical, Inorganic and Organic Chemistry
- Unit 19: Atmospheric Science and Climate Change.

5 Planning your programme

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 international GCSEs at good grades, and/or
- BTEC qualification(s) at Level 2
- other appropriate qualifications or achievement at year 11 or age 16 in core subjects. 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.

If students are studying in English we recommend that they have attained at least Level B2 in the Common European Framework of Reference for Languages or Pearson Global Scale of English 51. Please see resources available from Pearson at www.pearson.com/english.

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:

- Delivery guides are provided for each mandatory unit as well as a selection of optional units. These guides are intended to give an introducton to the unit, an overview of the assessment requirements, and a summary of the teaching content to be delivered and assessed.
- Sample delivery plans for all qualification sizes, designed to help you plan and deliver a teaching programme across a specified duration. These plans consist of the mandatory units required in each size as well as a selection of optional units recommended by us.
- Sample schemes of work are provided for each mandatory unit as well as a selection of optional units. These schemes of work are intended to show you how to deliver the teaching and assessment for each unit within the guided learning hours given. Each scheme of work provides an example of how each lesson can be structured, identifying key teaching topic areas, and how this content can be delivered using a range of teacher and student activities. These are available in Word™ format for ease of customisation.
- Our resources guide sets out the minimum resources required to support the planning, teaching and preparation for assessments for all units in this specification.

- For units assessed with a Pearson Set Assignment Brief, we have provided a sample assignment as an example of the form of assessment for the unit. For the remaining units, we will allow you to set your own assignments, according to your students' preferences and to link with your local employment profile. We also provide Authorised Assignment Briefs, which are approved by Pearson Standards Verifiers.
- Our transition guide highlights key similarities and differences between the new qualifications and Pearson's 2020 BTEC International Level 3 Qualifications in Applied Science, which these qualifications replace.

Using Pearson Progress to support the planning, delivery and management of internal assessments

Pearson Progress is a digital support system that helps you to manage the assessment and quality assurance of these qualifications. This application supports the delivery, assessment and quality assurance of International BTECs in centres and supports teachers, assessors and students as follows:

- course creation
- creating and verifying assignments
- creating assessment plans and recording assessment decisions
- upload of assignment evidence
- tracking progress of every student.

The system is accessible to teachers and students so that they both can track their progress.

Training and support from Pearson

There are many people available to support you and give you advice and guidance on the delivery of these qualifications. They include the following:

- Subject Advisors – they understand all Pearson qualifications in their sector and can answer sector-specific queries on planning, teaching, learning and assessment.
- Standards Verifiers – they can support you with preparing your assignments, ensuring that your assessment plan is set up correctly, and support you in preparing student work and providing quality assurance through sampling.
- Regional teams – they are regionally based and have a full overview of the BTEC qualifications and of the support and resources that Pearson provides. Regions often run network events.
- Customer Services – the 'Support for You' section of our website gives the different ways in which you can contact us for general queries. For specific queries, our service operators can direct you to the relevant person or department.

Pearson provides a range of training and professional development events to support the introduction, delivery, assessment and administration of BTEC International Level 3 qualifications. These sector-specific events, developed and delivered by specialists, are available both face to face and online.

We also offer 'Getting Ready to Teach' events which are designed to get teachers ready for delivery of the BTEC International Level 3 qualifications. They include an overview of qualification structures, planning and preparation for internal assessment, and quality assurance.

Beyond the 'Getting Ready to Teach' professional development events, there are opportunities for teachers to attend sector- and role-specific events. These events are designed to connect practice to theory; they provide teacher support and networking opportunities with delivery, learning and assessment methodology.

Details of our training and professional development programme can be found on our website.

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.

Eligibility for an award

In order to be awarded a qualification, a student must complete all units AND achieve a Pass or above in all mandatory units unless otherwise specified. Refer to the structure in *Section 3 Structure*. Students must:

- complete and **have an outcome** (D, M, P or U) for all units within a valid combination
- achieve all the **mandatory units at Pass or above** shown in *Section 3 Structure*
- achieve the **minimum number of points** at a grade threshold.

It is the responsibility of a centre to ensure that a correct unit combination is adhered to. Students who do not achieve the required minimum grade (P) in units shown in the structure will not achieve a qualification.

Students who do not achieve sufficient points for a qualification or who do not achieve all the required units may be eligible to achieve a smaller qualification in the same suite, provided they have completed and achieved the correct combination of units and met the appropriate qualification grade points threshold.

Awarding 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 International Level 3 qualifications are awarded at the grade ranges shown in the table below.

Qualification	Available grade range
Certificate, Extended Certificate, Foundation Diploma	P to D*
Diploma	PP to D*D*
Extended Diploma	PPP to D*D*D*

The *Calculation of the qualification grade* table, shown later 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 units

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

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

Claiming the qualification grade

Subject to eligibility, Pearson will automatically calculate the qualification grade for your students when the 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 *Calculation of the qualification grade* table for the cohort.

Calculation of the qualification grade

Applicable for registration from 1 September 2027.

Certificate		Extended Certificate		Foundation Diploma		Diploma		Extended Diploma	
180 GLH		360 GLH		540 GLH		720 GLH		1080 GLH	
Grade	Points threshold	Grade	Points threshold	Grade	Points threshold	Grade	Points threshold	Grade	Points threshold
Unclassified	0	U	0	U	0	U	0	U	0
Pass	18	P	36	P	54	PP	72	PPP	108
						MP	88	MPP	124
								MMP	140
Merit	26	M	52	M	78	MM	104	MMM	156
						DM	124	DMM	176
								DDM	196
Distinction	37	D	74	D	108	DD	144	DDD	216
						D*D	162	D*DD	234
								D*D*D	252
Distinction*	45	D*	90	D*	138	D*D*	180	D*D*D*	270

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

Example grading tables

In this section, you will find examples of how students can meet a range of qualification grade thresholds based on the unit points accumulated, to determine an overall qualification grade.

Pearson BTEC International Level 3 Certificate in Applied Science (180 GLH)

Achievement of a Certificate with a Merit grade

Unit number	GLH	Type (Int/PSA)	Grade	Unit points
1	60	PSA	Pass	6
2	60	PSA	Merit	10
3	60	PSA	Distinction	16
TOTAL	**180**		**Merit**	**32**

In this example, the student has sufficient points for a Merit grade. The student has met the minimum requirement for Pass or higher in the mandatory unit.

Pearson BTEC International Level 3 Extended Certificate in Applied Science (360 GLH)

Achievement of an Extended Certificate with a Pass grade

Unit number	GLH	Type (Int/PSA)	Grade	Unit points
1	60	PSA	Distinction	16
2	60	PSA	Merit	10
3	60	PSA	Pass	6
12	60	Int	Pass	6
13	60	Int	Pass	6
14	60	Int	Pass	6
TOTAL	**360**		**Pass**	**50**

In this example, the student has sufficient points for a Pass grade. The student has met the minimum requirement for Pass or higher in the mandatory units.

Pearson BTEC International Level 3 Foundation Diploma in Applied Science (540 GLH)

Achievement of a Foundation Diploma with a Distinction grade

Unit number	GLH	Type (Int/PSA)	Grade	Unit points
1	60	PSA	Distinction	16
2	60	PSA	Merit	10
3	60	PSA	Distinction	16
9	60	Int	Distinction	16
10	60	Int	Pass	6
12	60	Int	Merit	10
13	60	Int	Merit	10
14	60	Int	Distinction	16
15	60	Int	Distinction	16
TOTAL	**540**		**Distinction**	**116**

In this example, the student has sufficient points for a Distinction grade. The student has met the minimum requirement for Pass or higher in the mandatory units.

Pearson BTEC International Level 3 Diploma in Applied Science (720 GLH)

Achievement of a Diploma with a PP grade

Unit number	GLH	Type (Int/PSA)	Grade	Unit points
1	60	PSA	Merit	10
2	60	PSA	Merit	10
3	60	PSA	Pass	6
4	60	PSA	Pass	6
5	60	PSA	Pass	6
9	60	Int	Pass	6
10	60	Int	Merit	10
12	60	Int	Unclassified	0
13	60	Int	Unclassified	0
14	60	Int	Merit	10
15	60	Int	Merit	10
16	60	Int	Merit	10
TOTAL	**720**		**PP**	**84**

In this example, the student has sufficient points for a PP grade despite receiving an Unclassified result for Units 12 and 13. The student has met the minimum requirement for Pass or higher in the mandatory units.

Pearson BTEC International Level 3 Diploma in Applied Science (720 GLH)

Achievement of a Diploma with an MM grade

Unit number	GLH	Type (Int/PSA)	Grade	Unit points
1	60	PSA	Merit	10
2	60	PSA	Merit	10
3	60	PSA	Distinction	16
4	60	PSA	Pass	6
5	60	PSA	Distinction	16
9	60	Int	Pass	6
10	60	Int	Merit	10
12	60	Int	Pass	6
13	60	Int	Pass	6
14	60	Int	Merit	10
15	60	Int	Distinction	16
16	60	Int	Merit	10
TOTAL	**720**		**MM**	**122**

In this example, the student has sufficient points for an MM grade. The student has met the minimum requirement for Pass or higher in the mandatory units.

Pearson BTEC International Level 3 Diploma in Applied Science (720 GLH)

An Unclassified result for a Diploma

Unit number	GLH	Type (Int/PSA)	Grade	Unit points
1	60	PSA	Unclassified	0
2	60	PSA	Merit	10
3	60	PSA	Distinction	16
4	60	PSA	Pass	6
5	60	PSA	Distinction	16
9	60	Int	Pass	6
10	60	Int	Merit	10
12	60	Int	Pass	6
13	60	Int	Pass	6
14	60	Int	Merit	10
15	60	Int	Distinction	16
16	60	Int	Merit	10
TOTAL	**720**		**Unclassified**	**112**

In this example, the student has sufficient points for an MM grade but has not met the minimum requirement for Pass or higher in all of the mandatory units. An Unclassified result for Unit 1.

Pearson BTEC International Level 3 Extended Diploma in Applied Science (1080 GLH)

Achievement of an Extended Diploma with an MMM grade

Unit number	GLH	Type (Int/PSA)	Grade	Unit points
1	60	PSA	Pass	6
2	60	PSA	Merit	10
3	60	PSA	Pass	6
4	60	PSA	Pass	6
5	60	PSA	Distinction	16
6	60	PSA	Pass	6
7	60	PSA	Pass	6
8	60	PSA	Merit	10
9	60	Int	Pass	6
10	60	Int	Distinction	16
11	60	Int	Merit	10
12	60	Int	Pass	6
13	60	Int	Unclassified	0
14	60	Int	Merit	10
15	60	Int	Pass	6
17	60	Int	Merit	10
19	60	Int	Distinction	16
22	60	Int	Merit	10
TOTAL	**1080**		**MMM**	**156**

In this example, the student has sufficient points for an MMM grade despite receiving Unclassified result for Unit 13. The student has met the minimum requirement for Pass or higher in the mandatory units.

Pearson BTEC International Level 3 Extended Diploma in Applied Science (1080 GLH)

Achievement of an Extended Diploma with a DDD grade

Unit number	GLH	Type (Int/PSA)	Grade	Unit points
1	60	PSA	Distinction	16
2	60	PSA	Merit	10
3	60	PSA	Merit	10
4	60	PSA	Pass	6
5	60	PSA	Distinction	16
6	60	PSA	Pass	6
7	60	PSA	Distinction	16
8	60	PSA	Distinction	16
9	60	Int	Merit	10
10	60	Int	Distinction	16
11	60	Int	Merit	10
12	60	Int	Distinction	16
13	60	Int	Merit	10
14	60	Int	Merit	10
15	60	Int	Distinction	16
17	60	Int	Merit	10
19	60	Int	Distinction	16
22	60	Int	Merit	10
TOTAL	**1080**		**DDD**	**220**

In this example, the student has sufficient points for a DDD grade. The student has met the minimum requirement for Pass or higher in the mandatory units.

Pearson BTEC International Level 3 Extended Diploma in Applied Science (1080 GLH)

An Unclassified result for an Extended Diploma

Unit number	GLH	Type (Int/PSA)	Grade	Unit points
1	60	PSA	Unclassified	0
2	60	PSA	Merit	10
3	60	PSA	Pass	6
4	60	PSA	Pass	6
5	60	PSA	Pass	6
6	60	PSA	Pass	6
7	60	PSA	Merit	10
8	60	PSA	Merit	10
9	60	Int	Merit	10
10	60	Int	Pass	6
11	60	Int	Merit	10
12	60	Int	Unclassified	0
13	60	Int	Pass	6
14	60	Int	Merit	10
15	60	Int	Unclassified	0
17	60	Int	Merit	10
19	60	Int	Pass	6
22	60	Int	Merit	10
TOTAL	**1080**		**Unclassified**	**122**

In this example, the student has sufficient points for a PPP grade but has not met the minimum requirement for Pass or higher in all of the mandatory units. An Unclassified result for Unit 1.

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.
Clear/ly	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, for example: 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.

Term	Definition
Consistent	Students demonstrate reliable and constant practice that maintains a set standard.
Create/produce	Students generate an idea/outcome to specific criteria.
Demonstrate	Students carry out and apply knowledge, understanding and/or skills in a practical situation.
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.
Develop	Students apply a process of improving/progressing skills, concepts or work in order to produce outcomes.
Discuss	An issue, situation or 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.
Effective	Students demonstrate skills or provide outcomes that are well developed with a range of proficient qualities and that achieve objectives.
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.

Term	Definition
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.
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.
Refine/optimise	Students make considered improvements to outcomes.
Review	Students consider evidence in order to make judgements about the qualities.
Understand	Students demonstrate insight or ability to interpret a subject.
Undertake	Students demonstrate skills through practical activities, often referring to given processes or techniques.

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 use 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.
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	• Defines 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	• Defines 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 considers the views of team members and consistently shows courtesy and fairness. • Completes activities in line with agreed role and responsibilities. • Provides 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. • 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 9
Have up-to-date knowledge of ways that technology is used within a sector.	Unit 9
Present ideas and findings using digital tools.	Unit 9
Use digital tools to manipulate data.	Unit 9

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 8
Use collaboration tools to meet with, share and collaborate with customers and colleagues.	Unit 9

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 10
Set up accounts to complete transactions.	Unit 10

Digital security

Identify threats and keep digital tools safe:

Performance descriptor	Unit mapping
Understand the types of malware.	Unit 9
Understand the threats involved in carrying out online activities.	Unit 9
Protect personal and organisation information and data.	Unit 9
Keeping systems secure.	Unit 9

Handling data safely and securely

Follow correct procedures when handling personal and organisational data:

Performance descriptor	Unit mapping
Manage passwords and keep them secure.	Unit 9
Identify websites and services that are secure and insecure.	Unit 9
Understand the digital policy for a sector.	Unit 9
Understand the impact of online data.	Unit 9
Understand copyright and intellectual property.	Unit 9

Appendix 4 Sustainability framework

Sustainable development goal	Unit mapping
SDG 1: No poverty	Unit 22
SDG 2: Zero hunger	Unit 5
SDG 3: Good health and wellbeing	Unit 1, Unit 5
SDG 4: Quality education	Unit 5
SDG 6: Clean water and sanitation	Unit 18
SDG 7: Affordable and clean energy	Unit 5, Unit 18
SDG 9: Industry, innovation and infrastructure	Unit 18, Unit 22
SDG 11: Sustainable cities and communities	Unit 22
SDG 12: Responsible consumption and production	Unit 8
SDG 13: Climate action	Unit 5
SDG 14: Life below water	Unit 22
SDG15: Life on land	Unit 1

For information about Pearson Qualifications, including Pearson Edexcel, and BTEC visit qualifications.pearson.com

Edexcel and BTEC are registered trademarks of Pearson Education Limited
Pearson Education Limited. Registered in England and Wales No. 872828

Registered Office: 80 Strand, London WC2R ORL.

VAT Reg No GB 278 537121

Cover image © SurvivAI/ Stock.adobe.com

Publication code:
VQ000537