

# Pearson BTEC Level 3 National Extended Diploma in Forensic and Criminal Investigation

## Specification

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*First teaching from September 2018*

*First certification from 2020*

**Issue 8**





# **Pearson BTEC Level 3 National Extended Diploma in Forensic and Criminal Investigation**

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First teaching September 2018

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## **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.

This specification is Issue 8. We will inform centres of any changes to this issue. The latest issue can be found on our website.

*References to third-party material 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.)*

ISBN 978 1 446 93743 3

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# Welcome

With a track record built over 30 years of learner success, BTEC Nationals are widely recognised by industry and higher education as the signature vocational qualification at Level 3. They provide progression to the workplace either directly or via study at a higher level. Proof comes from YouGov research, which shows that 62% of large companies have recruited employees with BTEC qualifications. What's more, well over 100,000 BTEC students apply to UK universities every year and their BTEC Nationals are accepted by over 150 UK universities and higher education institutes for relevant degree programmes either on their own or in combination with A Levels.

## Why are BTECs so successful?

BTECs embody a fundamentally learner-centred approach to the curriculum, with a flexible, unit-based structure and knowledge applied in project-based assessments. They focus on the holistic development of the practical, interpersonal and thinking skills required to be able to succeed in employment and higher education.

When creating the BTEC Nationals in this suite, we worked with many employers, higher education providers, colleges and schools to ensure that their needs are met. Employers are looking for recruits with a thorough grounding in the latest industry requirements and work-ready skills such as teamwork. Higher education needs students who have experience of research, extended writing and meeting deadlines.

We have addressed these requirements with:

- a range of BTEC sizes, each with a clear purpose, so there is something to suit each learner's choice of study programme and progression plans
- refreshed content that is closely aligned with employers' and higher education needs for a skilled future workforce
- assessments and projects chosen to help learners progress to the next stage. This means some are set by you to meet local needs, while others are set and marked by Pearson so that there is a core of skills and understanding that is common to all learners. For example, a written test can be used to check that learners are confident in using technical knowledge to carry out a certain job.

We are providing a wealth of support, both resources and people, to ensure that learners and their teachers have the best possible experience during their course. See *Section 10* for details of the support we offer.

## A word to learners

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

Good luck, and we hope you enjoy your course.

## Collaborative development

Students completing their BTEC Nationals in Forensic and Criminal Investigation will be aiming 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, businesses and universities, and with the providers who will be delivering the qualifications.

To ensure that the content meets providers' needs and provides high-quality preparation for progression, we engaged experts. We are very grateful to all the university and further education lecturers, teachers, employers, professional body representatives and other individuals who have generously shared their time and expertise to help us develop these new qualifications.

In addition, universities have provided letters of support confirming that these qualifications meet their entry requirements. These letters can be viewed on our website.

## Summary of Pearson BTEC Level 3 National Extended Diploma in Forensic and Criminal Investigation specification Issue 8 changes

Summary of changes made between the previous issue and this current issue	Page number
Change made to <i>Unit 13: Forensic Genetics</i> wording in <i>Summary of unit</i> section under <i>Learning aim B Recommended assessment approach</i> to remove reference to 'organic' extraction.	Page 134
Changes to <i>Unit 13: Forensic Genetics</i> wording in sections <i>Content</i> Learning aim B, under B1, to remove references to 'using chloroform/phenol' and 'organic' extraction.	Page 135
Changes to <i>Unit 13: Forensic Genetics</i> wording in section <i>Essential information for assessment decisions</i> under Learning aim B, merit and pass standards, to remove references to 'organic' extraction. Learning aim C.	Pages 140, 141

If you need further information on these changes or what they mean, contact us via our website at: [qualifications.pearson.com/en/support/contact-us.html](http://qualifications.pearson.com/en/support/contact-us.html).



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# Introduction to BTEC National qualifications for the forensic and criminal investigation sector

This specification contains the information you need to deliver the Pearson BTEC Level 3 National Extended Diploma in Forensic and Criminal Investigation. The specification signposts you to additional handbooks and policies. It includes all the units for this qualification.

This qualification is part of the suite of forensic and criminal investigation qualifications offered by Pearson. In the suite there are qualifications that focus on different progression routes, allowing learners to choose the one best suited to their aspirations.

All qualifications in the suite share some common units and assessments, allowing learners some flexibility in moving between sizes. The qualification titles are given below.

Some BTEC National qualifications provide a broad introduction that gives learners transferable knowledge and skills. These qualifications are for post-16 learners who want to continue their education through applied learning. The qualifications prepare learners for a range of higher education courses and job roles related to a particular sector. They provide progression either by meeting entry requirements in their own right or by being accepted alongside other qualifications at the same level and adding value to them.

In the forensic and criminal investigation sector these qualifications are:

Pearson BTEC Level 3 National Foundation Diploma in Forensic Investigation (510 GLH)  
(603/0251/3)

Pearson BTEC Level 3 National Diploma in Forensic and Criminal Investigation (720 GLH)  
(603/0246/X)

Pearson BTEC Level 3 National Extended Diploma in Forensic and Criminal Investigation (1080 GLH)  
(603/0247/1).

This specification signposts all the other essential documents and support that you need as a centre in order to deliver, assess and administer the qualification, including the staff development required. A summary of all essential documents is given in *Section 7*. Information on how we can support you with this qualification is given in *Section 10*.

The information in this specification is correct at the time of publication.

## Total Qualification Time

For all regulated qualifications, Pearson specifies a total number of hours that it is estimated learners 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 learners. Guided learning includes the time required for learners to complete external assessment under examination or supervised conditions.

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

BTEC Nationals have been designed around the number of hours of guided learning expected. Each unit in the qualification has a GLH value of 60, 90 or 120. 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 all the qualifications in this sector and their GLH and TQT values.

## Qualifications, sizes and purposes at a glance

Title	Size and structure	Summary purpose
<b>Pearson BTEC Level 3 National Foundation Diploma in Forensic Investigation</b>	510 GLH (650 TQT) Equivalent in size to 1.5 A Levels, six units of which four are mandatory and two are external. Mandatory content (76%). External assessment (41%).	Designed as a one-year, full-time course of study, or as part of a two-year, full-time study programme for learners who wish to study another area alongside it, which may contrast or complement the qualification. The qualification supports progression to higher education if taken as part of a programme of study that includes other BTEC Nationals or A Levels.
<b>Pearson BTEC Level 3 National Diploma in Forensic and Criminal Investigation</b>	720 GLH (930 TQT) Equivalent in size to two A Levels, eight units of which six are mandatory and three are external. Mandatory content (83%). External assessment (46%).	Designed to be the substantive part of a 16–19 study programme for learners who want a strong core of sector study. The qualification may be complemented with other BTEC Nationals or A Levels to support progression to higher education courses in forensics and criminology. The additional qualification(s) studied allows learners either to give breadth to their study by choosing a contrasting subject, or to give their studies more focus by choosing a complementary subject.
<b>Pearson BTEC Level 3 National Extended Diploma in Forensic and Criminal Investigation</b>	1080 GLH (1395 TQT) Equivalent in size to three A Levels, thirteen units of which seven are mandatory and four are external. Mandatory content (67%). External assessment (42%).	Designed as a two-year, full-time course that meets entry requirements in its own right for learners who want to progress to higher education courses in the forensic and criminal investigation sector before entering employment.

*Learners must not register on the BTEC Level 3 Nationals in Applied Science at the same time as the BTEC Level 3 Nationals in Forensic and Criminal Investigation qualifications, due to overlap of content and assessment.*

## Structures of the qualifications at a glance

This table shows all the units and the qualifications to which they contribute. The full structure for this Pearson BTEC Level 3 National in Forensic and Criminal Investigation is shown in *Section 2*. **You must refer to the full structure to select units and plan your programme.**

### Key

	Unit assessed externally	<b>M</b>	Mandatory units	<b>O</b>	Optional units
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Unit (number and title)	Unit size (GLH)	Foundation Diploma (510 GLH)	Diploma (720 GLH)	Extended Diploma (1080 GLH)
1 Principles and Applications of Science I*	90	M	M	M
2 Practical Scientific Procedures and Techniques*	90	M	M	M
3 Science Investigation Skills*	120	M	M	M
4 Forensic Investigation Procedures in Practice	90	M	M	M
5 Applications of Criminology	120		M	M
6 Criminal Investigation Procedures in Practice	90		M	M
7 Applications of Criminal and Forensic Psychology	120			M
8 Physiology of Human Body Systems*	60	O	O	O
9 Environmental Forensics	60	O	O	O
10 Forensic Fire Investigation*	60	O	O	O
11 Forensic Traffic Collision Investigation*	60	O	O	O
12 Forensic Photography	60	O	O	O
13 Forensic Genetics	60	O	O	O
14 Forensic Anthropology and Archaeology	60		O	O
15 Practical Chemical Analysis*	60		O	O
16 Microbiology and Microbiological Techniques*	60			O

\*Units 1, 2, 3, 8, 10, 11, 15 and 16 are also part of the BTEC Level 3 Nationals in Applied Science.

## Qualification and unit content

Pearson has developed the content of the new BTEC Nationals in collaboration with employers and 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.

Each qualification in the suite has its own purpose. The mandatory and optional content provides a balance of breadth and depth, while retaining a degree of choice for individual learners to study content relevant to their own interests and progression choices. Also, the content may be applied during delivery in a way that is relevant to local employment needs.

The proportion of mandatory content ensures that all learners are following a coherent programme of study and acquiring the knowledge, understanding and skills that will be recognised and valued. Learners are expected to show achievement across mandatory units as detailed in *Section 2*.

BTEC Nationals have always required applied learning that brings together knowledge and understanding (the cognitive domain) with practical and technical skills (the psychomotor domain). This is achieved through learners performing vocational tasks that encourage the development of appropriate vocational behaviours (the affective domain) and transferable skills. Transferable skills are those such as communication, teamwork, research and analysis, which are valued in both higher education and the workplace.

Our approach provides rigour and balance, and promotes the ability to apply learning immediately in new contexts. Further details can be found in *Section 2*.

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

## Assessment

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

### Externally-assessed units

Each external assessment for a BTEC National is linked to a specific unit. All of the units developed for external assessment are of 90 or 120 GLH to allow learners to demonstrate breadth and depth of achievement. Each assessment is taken under specified conditions, then marked by Pearson and a grade awarded. Learners are permitted to resit external assessments during their programme. You should refer to our website for current policy information on permitted retakes.

The styles of external assessment used for qualifications in the BTEC Level 3 Forensic and Criminal Investigation suite are:

- examinations – all learners take the same assessment at the same time, normally with a written outcome
- set tasks – learners take the assessment during a defined window and demonstrate understanding through completion of a vocational task.

Some external assessments include a period of preparation using set information. External assessments are available twice a year. For detailed information on the external assessments please see the table in *Section 2*. For further information on preparing for external assessment see *Section 5*.

## **Internally-assessed units**

Most units in the sector are internally assessed and subject to external standards verification. This means that you set and assess the assignments that provide the final summative assessment of 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 *Section 6*.

In line with the requirements and guidance for internal assessment, you select the most appropriate assessment styles according to the learning set out in the unit. This ensures that learners are assessed using a variety of styles to help them develop a broad range of transferable skills. Learners 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 equipment.

You will make grading decisions based on the requirements and supporting guidance given in the units. Learners may not make repeated submissions of assignment evidence. For further information see *Section 6*.

## **Synoptic assessment**

Synoptic assessment requires learners to demonstrate that they can identify and use effectively, in an integrated way, an appropriate selection of skills, techniques, concepts, theories and knowledge from across the whole sector as relevant to a key task. BTEC learning has always encouraged learners to apply their learning in realistic contexts using scenarios and realistic activities that will permit learners to draw on and apply their learning. For these qualifications we have formally identified units which contain a synoptic assessment task. Synoptic assessment must take place after the teaching and learning of other mandatory units in order for learners to be able to draw from the full range of content. The synoptic assessment gives learners an opportunity to independently select and apply learning from across their programmes in the completion of a vocational task. Synoptic tasks may be in internally or externally assessed units. The particular unit that contains the synoptic tasks for this qualification is shown in the structure in *Section 2*.

## **Language of assessment**

Assessment of the internal and external units for these qualifications will be available in English. All learner work must be in English. A learner taking the qualifications may be assessed in British or Irish Sign Language where it is permitted for the purpose of reasonable adjustment. For information on reasonable adjustments see *Section 7*.

## Grading for units and qualifications

Achievement in the qualification requires a demonstration of depth of study in each unit, assured acquisition of a range of practical skills required for employment or progression to higher education, and successful development of transferable skills. Learners achieving a qualification will have achieved across mandatory units, including external and synoptic assessment.

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

Qualifications in the suite are graded using a scale of P to D\*, **or** PP to D\*D\*, **or** PPP to D\*D\*D\*. Please see *Section 9* 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 learner performance and in consultation with key users of the qualification.

## UCAS Tariff points

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

# 1 Qualification purpose

## Pearson BTEC Level 3 National Extended Diploma in Forensic and Criminal Investigation

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

### Who is this qualification for?

The Pearson BTEC Level 3 National Extended Diploma in Forensic and Criminal Investigation is intended to be an Applied General qualification for post-16 learners wanting to continue their education through applied learning, and who aim to progress to higher education courses. The qualification is wide-ranging and equivalent in size to three A Levels. It has been designed as a full two-year programme. Learners wishing to take this BTEC will have successfully completed a Level 2 programme of learning with GCSEs and potentially some vocational qualifications.

### What does this qualification cover?

The content of this qualification has been developed in consultation with academics to ensure that it supports progression to higher education.

Everyone taking this qualification will study and achieve the seven mandatory units, including four units that are externally assessed. The seven mandatory units are:

- Unit 1: Principles and Applications of Science I
- Unit 2: Practical Scientific Procedures and Techniques
- Unit 3: Science Investigation Skills
- Unit 4: Forensic Investigation Procedures in Practice
- Unit 5: Applications of Criminology
- Unit 6: Criminal Investigation Procedures in Practice
- Unit 7: Applications of Criminal and Forensic Psychology.

Learners choose six optional units from a group that has been designed to support progression to a range of sector-related courses in higher education and to link with relevant occupational areas. The optional units offer breadth and depth of topic areas that are relevant to the forensic and criminal investigation sector. These include forensic archaeology and anthropology, and environmental forensics.

### What could this qualification lead to?

In addition to the applied science, forensic science, criminology, and criminal and forensic psychology sector-specific content outlined above, the requirements of the qualification will mean learners develop the transferable and higher-order skills that are highly regarded by higher education and employers.

For example, the study of applied and forensic science, criminology, and criminal and forensic psychology particularly encourages development of skills such as evaluation, analysis and synthesis. These skills are developed through the variety of approaches to teaching and learning enabled by the specification. In particular, the investigative project and contemporary science issues allow learners to demonstrate their ability to plan, research, problem solve, assimilate data, and draw together and communicate their findings.

The range of higher education degree courses that learners can progress to include:

- BSc (Hons) in Policing and Criminal Investigation
- BSc (Hons) in Forensic Science and Criminal Investigation
- BSc (Hons) in Forensic Science
- BSc (Hons) in Forensic Psychology

- BSc (Hons) in Psychology and Criminology
- BSc (Hons) in Forensic Psychology and Criminal Investigation
- BA (Hons) in Criminology
- BA (Hons) in Criminology and Law.

The qualification is intended to carry UCAS points and is recognised by higher education providers as meeting admission requirements for many relevant courses.

Learners should always check the entry requirements for degree programmes with specific higher education providers.

### **How does the qualification provide employability skills?**

In the BTEC National units there are opportunities during the teaching and learning phase to give learners practice in developing employability skills. Where employability skills are referred to in this specification, we are generally referring to skills in the following three main categories:

- **cognitive and problem-solving skills:** using critical thinking, approaching non-routine problems applying expert and creative solutions, using systems and technology
- **interpersonal skills:** communicating, working collaboratively, negotiating and influencing
- **intrapersonal skills:** self-management, adaptability and resilience, self-monitoring and development, self-presentation.

There are also specific requirements in some units for assessment of these skills where relevant, for example, where learners are required to undertake real or simulated activities.

### **How does the qualification provide transferable knowledge and skills for higher education?**

All BTEC Nationals provide transferable knowledge and skills that prepare learners for progression to university. The transferable skills that universities value include:

- the ability to learn independently
- the ability to research actively and methodically
- being able to give presentations and being active group members.

BTEC learners can also benefit from opportunities for deep learning where they are able to make connections among units and select areas of interest for detailed study. BTEC Nationals provide a vocational context in which learners can develop the knowledge and skills required for particular degree courses, including:

- reading scientific and technical texts
- effective writing
- practical and analytical skills
- preparation for assessment methods used in degrees.

## 2 Structure

### Qualification structure

#### Pearson BTEC Level 3 National Extended Diploma in Forensic and Criminal Investigation

##### Mandatory units

There are seven mandatory units, three internal and four external. Learners must complete and achieve at Near Pass grade or above in all mandatory external units and achieve a Pass or above in all mandatory internal units.

##### Optional units

Learners must complete at least six optional units.

Pearson BTEC Level 3 National Extended Diploma in Forensic and Criminal Investigation				
Unit number	Unit title	GLH	Type	How assessed
<b>Mandatory units – learners complete and achieve all units</b>				
<b>1</b>	Principles and Applications of Science I	<b>90</b>	<b>Mandatory</b>	External
<b>2</b>	Practical Scientific Procedures and Techniques	<b>90</b>	<b>Mandatory</b>	Internal
<b>3</b>	Science Investigation Skills	<b>120</b>	<b>Mandatory</b>	External
<b>4</b>	Forensic Investigation Procedures in Practice	<b>90</b>	<b>Mandatory</b>	Internal
<b>5</b>	Applications of Criminology	<b>120</b>	<b>Mandatory</b>	External
<b>6</b>	Criminal Investigation Procedures in Practice	<b>90</b>	<b>Mandatory</b>	Internal
<b>7</b>	Applications of Criminal and Forensic Psychology	<b>120</b>	<b>Mandatory and Synoptic</b>	External
<b>Optional units – learners complete six units</b>				
<b>8</b>	Physiology of Human Body Systems	<b>60</b>	<b>Optional</b>	Internal
<b>9</b>	Environmental Forensics	<b>60</b>	<b>Optional</b>	Internal
<b>10</b>	Forensic Fire Investigation	<b>60</b>	<b>Optional</b>	Internal
<b>11</b>	Forensic Traffic Collision Investigation	<b>60</b>	<b>Optional</b>	Internal
<b>12</b>	Forensic Photography	<b>60</b>	<b>Optional</b>	Internal
<b>13</b>	Forensic Genetics	<b>60</b>	<b>Optional</b>	Internal
<b>14</b>	Forensic Anthropology and Archaeology	<b>60</b>	<b>Optional</b>	Internal
<b>15</b>	Practical Chemical Analysis	<b>60</b>	<b>Optional</b>	Internal
<b>16</b>	Microbiology and Microbiological Techniques	<b>60</b>	<b>Optional</b>	Internal

## External assessment

This is a summary of the type and availability of external assessment, which is of units making up 42% of the total qualification GLH. See *Section 5* and the units and sample assessment materials for more information.

Unit	Type	Availability
<b>Unit 1: Principles and Applications of Science I</b>	<ul style="list-style-type: none"> <li>• Written examination set and marked by Pearson.</li> <li>• 2 hours.</li> <li>• 90 marks.</li> </ul>	<b>Jan and May/June First assessment May/June from 2017</b>
<b>Unit 3: Science Investigation Skills</b>	<ul style="list-style-type: none"> <li>• A task set and marked by Pearson and completed under supervised conditions.</li> <li>• Part A and B are taken in a single session timetabled by Pearson.</li> <li>• Learners will have 45 minutes to review Part A before they complete Part B.</li> <li>• Part B will be one session lasting one hour and 30 minutes.</li> <li>• 60 marks.</li> </ul>	<b>Jan and May/June First assessment May/June 2017</b>
<b>Unit 5: Applications of Criminology</b>	<ul style="list-style-type: none"> <li>• A task set and marked by Pearson and completed under supervised conditions.</li> <li>• The supervised assessment period is 3 hours and must be completed in one sitting in a morning session timetabled by Pearson.</li> <li>• 60 marks.</li> </ul>	<b>Dec/Jan and May/June First assessment Jan 2019</b>
<b>Unit 7: Applications of Criminal and Forensic Psychology</b>	<ul style="list-style-type: none"> <li>• A task set and marked by Pearson and completed under supervised conditions.</li> <li>• The supervised assessment period is 3 hours and must be completed in one sitting in a morning session timetabled by Pearson.</li> <li>• 60 marks.</li> </ul>	<b>Dec/Jan and May/June First assessment Jan 2019</b>

*It is recommended by Pearson that learners do not attempt the assessment for Units 1 and 3 until a year of study has been completed.*

## **Synoptic assessment**

The mandatory synoptic assessment requires learners to apply learning from across the qualification to the completion of defined vocational tasks. Within the assessment for *Unit 7: Applications of Criminal and Forensic Psychology* learners complete the key vocational task of analysing a case study containing a crime scenario and apply psychological approaches to help explain the criminal behaviour and consider appropriate treatments for offenders. Learners will also complete offender profiling of potential suspects and assess its potential effectiveness. Learners complete the task using knowledge and understanding from their studies of the sector and apply both transferable and specialist knowledge and skills.

In delivering the unit you need to encourage learners to draw on their broader learning so they will be prepared for the assessment.

## **Employer involvement in assessment and delivery**

You are encouraged to give learners opportunities to be involved with employers. See *Section 4* for more information.

# 3 Units

## Understanding your units

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

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

- internal units
- external units.

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

### Internal units

Section	Explanation
<b>Unit number</b>	The number is in a sequence in the sector. Numbers may not be sequential for an individual qualification.
<b>Unit title</b>	This is the formal title that we always use and it appears on certificates.
<b>Level</b>	All units are at Level 3 on the national framework.
<b>Unit type</b>	This shows if the unit is internal or external only. See structure information in <i>Section 2</i> for full details.
<b>GLH</b>	Units may have a GLH value of 120, 90 or 60 GLH. 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.
<b>Unit in brief</b>	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.
<b>Unit introduction</b>	This is designed with learners 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.
<b>Learning aims</b>	These help to define the scope, style and depth of learning of the unit. You can see where learners 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 <i>Appendix 2</i> .
<b>Summary of unit</b>	This new section helps teachers to see at a glance the main content areas against the learning aims and the structure of the assessment. The content areas and structure of assessment are required. The forms of evidence given are suitable to fulfil the requirements.
<b>Content</b>	This section sets out the required teaching content of the unit. Content is compulsory except when shown as 'e.g.'. Learners should be asked to complete summative assessment only after the teaching content for the unit or learning aim(s) has been covered.

Section	Explanation
<b>Assessment criteria</b>	<p>Each learning aim has Pass and Merit criteria. Each assignment has at least one Distinction criterion.</p> <p>A full glossary of terms used is given in <i>Appendix 2</i>. All assessors need to understand our expectations of the terms used.</p> <p>Distinction criteria represent outstanding performance in the unit. Some criteria require learners to draw together learning from across the learning aims.</p>
<b>Essential information for assignments</b>	<p>This shows the maximum number of assignments that may be used for the unit to allow for effective summative assessment, and how the assessment criteria should be used to assess performance.</p>
<b>Further information for teachers and assessors</b>	<p>The section gives you information to support the implementation of assessment. It is important that this is used carefully alongside the assessment criteria.</p>
<b>Resource requirements</b>	<p>Any specific resources that you need to be able to teach and assess are listed in this section. For information on support resources see <i>Section 10</i>.</p>
<b>Essential information for assessment decisions</b>	<p>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.</p>
<b>Links to other units</b>	<p>This section shows you the main relationship among units. This section can help you to structure your programme and make best use of materials and resources.</p>
<b>Employer involvement</b>	<p>This section gives you information on the units that can be used to give learners involvement with employers. It will help you to identify the kind of involvement that is likely to be successful.</p>

## External units

Section	Explanation
<b>Unit number</b>	The number is in a sequence in the sector. Numbers may not be sequential for an individual qualification.
<b>Unit title</b>	This is the formal title that we always use and it appears on certificates.
<b>Level</b>	All units are at Level 3 on the national framework.
<b>Unit type</b>	This shows if the unit is internal or external only. See structure information in <i>Section 2</i> for full details.
<b>GLH</b>	Units may have a GLH value of 120, 90 or 60 GLH. 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.
<b>Unit in brief</b>	A brief formal statement on the content of the unit.
<b>Unit introduction</b>	This is designed with learners 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.
<b>Summary of assessment</b>	This sets out the type of external assessment used and the way in which it is used to assess achievement.
<b>Assessment outcomes</b>	These show the hierarchy of knowledge, understanding, skills and behaviours that are assessed. Includes information on how this hierarchy relates to command terms in sample assessment materials (SAMs).
<b>Essential content</b>	For external units all the content is obligatory, the depth of content is indicated in the assessment outcomes and sample assessment materials (SAMs). The content will be sampled through the external assessment over time, using the variety of questions or tasks shown.
<b>Grade descriptors</b>	We use grading descriptors when making judgements on grade boundaries. You can use them to understand what we expect to see from learners at particular grades.
<b>Key terms typically used in assessment</b>	These definitions will help you analyse requirements and prepare learners for assessment.
<b>Resources</b>	Any specific resources that you need to be able to teach and assess are listed in this section. For information on support resources see <i>Section 10</i> .
<b>Links to other units</b>	This section shows the main relationship among units. This section can help you to structure your programme and make best use of materials and resources.
<b>Employer involvement</b>	This section gives you information on the units that can be used to give learners involvement with employers. It will help you to identify the kind of involvement that is likely to be successful.



## Index of units

This section contains all the units developed for this qualification. Please refer to *page 4* to check which units are available in all qualifications in the forensic and criminal investigation suite.

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# Unit 1: Principles and Applications of Science I

Level: **3**

Unit type: **External**

Guided learning hours: **90**

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## Unit in brief

This unit covers some of the key science concepts in biology, chemistry and physics.

## Unit introduction

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

The topic areas covered in this unit include: animal and plant cells; tissues; atomic structure and bonding; chemical and physical properties of substances related to their uses; waves and their application in communications.

Scientists and technicians working in the chemical industry need to have an understanding of atoms and electronic structure. This allows them to predict how chemical substances will react in the production of a wide range of products – anything from fertilisers in the farming industry to fragrances in the perfume industry. Metals play an important role in the construction industry, in providing the structure to buildings, as well as in electrical wiring and the production of decorative features. So understanding the chemical and physical properties of metals is essential when selecting appropriate building materials.

Medical professionals need to understand the structure and workings of cells. They build on this knowledge to understand how the body stays healthy as well as the symptoms and causes of some diseases. This allows them to diagnose and treat illnesses. The study of bacterial prokaryotic cells gives an understanding of how some other diseases are caused and can be treated.

Scientists and technicians in the food industry also need to understand the structure and function of plant cells to enable them to develop food crops that produce greater yields.

Knowledge of waves is essential in a wide range of industries and organisations. In the communication industry, scientists and technicians apply their knowledge of the electromagnetic spectrum when designing mobile phone and satellite communication, and fibre optics are used to transmit telephone and television signals. Fibre optics are also used in diagnostic tools in medicine.

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

## Summary of assessment

This unit is assessed through an examination worth 90 marks with a total time of 2 hours, undertaken in three timed sessions of 40 minutes for each of Biology, Chemistry and Physics. Learners must take all three parts of the single examination in the same series to be awarded a result.

The paper will include a range of question types, including multiple choice, calculations, short answer and open response. These question types will assess discrete knowledge and understanding of the content in this unit.

The assessment availability is January and May/June each year. The first assessment availability is May/June 2017.

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

## Assessment outcomes

**AO1** Demonstrate knowledge of scientific facts, terms, definitions and scientific formulae

Command words: give, label, name, state

Marks: ranges from 12 to 18 marks

**AO2** Demonstrate understanding of scientific concepts, procedures, processes and techniques and their application

Command words: calculate, compare, discuss, draw, explain, state, write

Marks: ranges from 39 to 45 marks

**AO3** Analyse, interpret and evaluate scientific information to make judgements and reach conclusions

Command words: calculate, comment, compare, complete, describe, discuss, explain, state

Marks: ranges from 18 to 24 marks

**AO4** Make connections, use and integrate different scientific concepts, procedures, processes or techniques

Command words: comment, compare, complete, discuss, explain

Marks: ranges from 9 to 12 marks

## Essential content

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

### A Periodicity and properties of elements

#### A1 Structure and bonding in applications in science

- Understand the electronic structure of atoms:
  - electronic orbitals
  - Aufbau principle
  - Bohr theory.
- Understand ionic bonding:
  - strong electrostatic attraction between oppositely charged ions
  - effects ionic radius and ionic charge have on the strength of ionic bonding
  - formation of ions in terms of electron loss or gain
  - electronic configuration diagrams of cations and anions.
- Understand covalent bonding:
  - strong electrostatic attraction between two nuclei and the shared pair(s) of electrons between them
  - dot and cross diagrams to show electrons in simple covalent molecules, including those with multiple bonds and dative covalent (coordinate) bonds
  - the relationship between bond lengths and bond strengths in covalent bonds
  - tetrahedral basis of organic chemistry.
- Understand metallic bonding:
  - de-localised electrons
  - positive metal ions
  - regular layer structure.
- Understand the following intermolecular forces:
  - van der Waals
  - dipole-dipole
  - hydrogen bonding.
- Understand the following:
  - balanced equations
  - relative atomic mass
  - atomic number and relative molecular mass
  - moles, molar masses and molarities.
- Understand the quantities used in chemical reactions:
  - mass, volume of solution, concentration
  - reacting quantities
  - percentage yields.

**A2 Production and uses of substances in relation to properties**

- Understand the periodic table:
  - Periods 1, 2, 3 and 4
  - groups – s block, p block, d block
  - layout of periodic table in relation to s, p, d notation
  - electronic arrangement of elements using s, p, d notation.
- Understand the physical properties of elements:
  - first ionisation energy
  - reasons for trends in ionisation energy across Periods 2–4 and down groups 1, 2 and 7
  - electron affinity
  - atomic radius
  - ionic radius
  - electronegativity
  - type of bonding in the element
  - trends – melting point and boiling point
  - physical properties of metals – electrical conductivity, thermal conductivity, malleability, ductility.
- Understand the chemical properties of elements:
  - products and reactivity of all Period 2 and 3 elements with oxygen
  - products and reactivity of metals with oxygen, water, dilute hydrochloric acid and dilute sulfuric acid
  - position of metals in the reactivity series in relation to position in the periodic table
  - oxidation
  - reduction
  - variable oxidation states of transition metal ions
  - displacement reactions of metals/halogens
  - uses and applications of substances produced within this learning aim.

**B Structure and functions of cells and tissues****B1 Cell structure and function**

- Know that cell theory is a unifying concept stating that cells are a fundamental unit of structure, function and organisation in all living organisms.
- Understand the ultrastructure and function of organelles in the following cells:
  - prokaryote cells (bacterial cell) – nucleoid, plasmids, 70S ribosomes, capsule, cell wall
  - eukaryotic cells (plant and animal cells) – plasma membrane, cytoplasm, nucleus, nucleolus, endoplasmic reticulum (smooth and rough), Golgi apparatus, vesicles, lysosomes, 80S ribosomes, mitochondria, centriole
  - eukaryotic cells (plant-cell specific) – cell wall, chloroplasts, vacuole, tonoplast, amyloplasts, plasmodesmata, pits.
- Recognise cell organelles from electron micrographs and the use of light microscopes.
- Understand the similarities and differences between plant and animal cell structure and function.
- Understand how to distinguish between gram-positive and gram-negative bacterial cell walls and why each type reacts differently to some antibiotics.
- Calculate magnification and size of cells and organelles from drawings or images.

**B2 Cell specialisation**

Understand cell specialisation in terms of structure and function, to include:

- palisade mesophyll cells in a leaf
- sperm and egg cells in reproduction
- root hair cells in plants
- white blood cells
- red blood cells.

**B3 Tissue structure and function**

- Understand the structure and function of epithelial tissue, to include:
  - squamous as illustrated by the role of alveolar epithelium in gas exchange to include the effect of chronic obstructive pulmonary disease (COPD) in smokers
  - columnar as illustrated by goblet cells and ciliated cells in the lungs to include their role in protecting lungs from pathogens.
- Understand the structure and function of endothelial tissue, as illustrated by blood vessels in the cardiovascular system, including the risk factors that damage endothelial cells and affect the development of atherosclerosis.
- Understand the structure and function of muscular tissue, to include:
  - the microscopic structure of a skeletal muscle fibre
  - structural and physiological differences between fast- and slow-twitch muscle fibres and their relevance in sport.
- Understand the structure and function of nervous tissue, to include:
  - non-myelinated and myelinated neurones
  - the conduction of a nerve impulse (action potential) along an axon, including changes in membrane permeability to sodium and potassium ions and the role of the myelination in saltatory conduction
  - interpretation of graphical displays of a nerve impulse and electrocardiogram (ECG) recordings
  - synaptic structure and the role of neurotransmitters, including acetylcholine
  - how imbalances in certain, naturally occurring brain chemicals can contribute to ill health, including dopamine in Parkinson's disease and serotonin in depression
  - the effects of drugs on synaptic transmission, including the use of L-Dopa in the treatment of Parkinson's disease.

**C Waves in communication****C1 Working with waves**

- Understand the features common to all waves and use the following terms as applied to waves:
  - periodic time
  - speed
  - wavelength
  - frequency
  - amplitude
  - oscillation.
- Graphical representation of wave features.
- Understand the difference between the two main types of wave:
  - transverse
  - longitudinal.
- Understand concepts of displacement, coherence, path difference, phase difference, superposition as applied to diffraction gratings.

- Understand the industrial application of diffraction gratings, to include:
  - emission spectra
  - identifying gases.

- Be able to use the wave equation:

$$v = f\lambda$$

- Understand the concept and applications of stationary waves resonance.
- Musical instruments.

- Be able to use the equation:

$$\text{calculation of speed } v = \sqrt{\frac{T}{\mu}}$$

## C2 Waves in communication

- Understand the principles of fibre optics:

- refractive index  $n = \frac{c}{v} = \frac{\sin i}{\sin r}$

- total internal reflection
- calculation of critical angles at a glass–air interface:

$$\sin c = \frac{1}{n}$$

- Understand the applications of fibre optics in medicine to include endoscopes.
- Understand the applications of fibre optics in communication, to include:
  - analogue and digital signals: analogue-to-digital conversion, broadband.

## C3 Use of electromagnetic waves in communication

- Understand that all electromagnetic waves travel with the same speed in a vacuum.
- Be able to use the inverse square law in relation to the intensity of a wave:

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

- Understand how the regions of the electromagnetic spectrum are grouped according to the frequency.
- Understand how the applications of electromagnetic waves in communications are related to frequency, including:
  - satellite communication
  - mobile phones
  - Bluetooth®
  - infrared
  - Wi-Fi.

## Grade descriptors

To achieve a grade learners are expected to demonstrate these attributes across the essential content of the unit. The principle of best fit will apply in awarding grades.

### Level 3 Pass

Learners will be able to recall, select and apply scientific knowledge and understanding to vocational and realistic situations. They will be able to use scientific terminology and concepts in given situations, and to use given information and apply appropriate mathematical and technical skills in context. Learners will be able to interpret and analyse information in order to make valid judgements.

### Level 3 Distinction

Learners will be able to integrate relevant scientific knowledge and understanding from different areas to demonstrate a deeper understanding of how these apply to vocational and realistic situations. They will be able to use scientific terminology and concepts, communicating consistently and effectively in given situations. They will be able to select relevant information and apply appropriate mathematical and technical skills to justify decisions or solve problems in context. Learners will be able to interpret and analyse information in order to make valid judgements that are supported by evidence, with awareness of limitations.

## Key terms typically used in assessment

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

Please note: the list below will not necessarily be used in every paper/session and is provided for guidance only. Only a single command word will be used per item.

Command or term	Definition
Add/label	Learners label or add to a stimulus material given in the question, for example labelling a diagram or adding units to a table.
Assess	Learners give careful consideration to all the factors or events that apply and identify which are the most important or relevant. Make a judgement on the importance of something and come to a conclusion where needed.
Calculate	Learners obtain a numerical answer, showing relevant working. If the answer has a unit, this must be included.
Comment on	Learners synthesise a number of variables from data/ information to form a judgement. More than two factors need to be synthesised.
Compare	Learners look for the similarities and differences of two (or more) things. Should not require the drawing of a conclusion. Answer must relate to both (or all) things mentioned in the question. The answer must include at least one similarity and one difference.
Complete	Learners complete a table/diagram.
Criticise	Learners inspect a set of data, an experimental plan or a scientific statement and consider the elements. Look at the merits and/or faults of the information presented and back up judgements made.
Deduce	Learners draw/reach conclusion(s) from the information provided.

Command or term	Definition
Derive	Learners combine two or more equations or principles to develop a new equation.
Describe	Learners give an account of something. Statements in the response need to be developed as they are often linked but do not need to include a justification or reason.
Determine	Learners' answers must have an element that is quantitative from the stimulus provided, or must show how the answer can be reached quantitatively. To gain maximum marks there must be a quantitative element to the answer.
Devise	Learners plan or invent a procedure from existing principles/ideas.
Discuss	Learners identify the issue/situation/problem/argument that is being assessed in the question. Explore all aspects of an issue/situation/problem/argument. Investigate the issue/situation, etc. by reasoning or argument.
Draw	Learners produce a diagram, either using a ruler or using freehand.
Evaluate	Learners review information then bring it together to form a conclusion, drawing on evidence, including strengths, weaknesses, alternative actions, relevant data or information. Come to a supported judgement of a subject's qualities and relation to its context.
Explain	Learners' explanations require a justification/ exemplification of a point. The answer must contain some element of reasoning/justification – this can include mathematical explanations.
Give/state/name	These generally require recall of one or more pieces of information.
Give a reason why	When a statement has been made and the requirement is only to give the reasons why.
Identify	Usually requires some key information to be selected from a given stimulus/resource.
Plot	Learners produce a graph by marking points accurately on a grid from data that is provided and then drawing a line of best fit through these points. A suitable scale and appropriately labelled axes must be included if these are not provided in the question.
Predict	Learners give an expected result.
Show that	Learners prove that a numerical figure is as stated in the question. The answer must be to at least one more significant figure than the numerical figure in the question.
Sketch	Learners produce a freehand drawing. For a graph this would need a line and labelled axes with important features indicated. The axes are not scaled.

<b>Command or term</b>	<b>Definition</b>
State and justify/identify and justify	When a selection is made and a justification has to be given for the selection.
State what is meant by	When the meaning of a term is expected but there are different ways in which this meaning can be described.
Write	When the question asks for an equation.

## Links to other units

This unit links to:

- Unit 2: Practical Scientific Procedures and Techniques.
- Unit 3: Science Investigation Skills.
- Unit 4: Forensic Investigation Procedures in Practice
- Unit 7: Applications of Criminal and Forensic Psychology

This unit also links to a wide range of optional units available across the qualification.

## Employer involvement

Centres may involve employers in the delivery of this unit if there are local opportunities. There is no specific guidance related to this unit.

# Unit 2: Practical Scientific Procedures and Techniques

Level: **3**

Unit type: **Internal**

Guided learning hours: **90**

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## Unit in brief

Learners will be introduced to quantitative laboratory techniques, calibration, chromatography, calorimetry and laboratory safety, which are relevant to the chemical and life science industries.

## Unit introduction

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

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

The fundamental knowledge, practical skills, transferable skills – for example, organisation, self-assessment and problem-solving, and the ability to interpret data – all developed in this unit will give you confidence when you undertake the more complex practical techniques involved in higher education science courses such as biochemistry, chemistry, forensic science and environmental science.

The experience you gain will be invaluable when you begin your career as a trainee laboratory technician in industries such as contract analysis, oil, biopharmaceuticals, water treatment, and polymers. Employers in these industries will appreciate your ability to follow written scientific procedures and your desire to ensure accuracy by using techniques correctly and by checking that equipment – for example, pipettes, balances, pH meters and thermometers – is calibrated correctly and that appropriate standard calibration documentation has been completed.

## Learning aims

In this unit you will:

- A** Undertake titration and colorimetry to determine the concentration of solutions
- B** Undertake calorimetry to study cooling curves
- C** Undertake chromatographic techniques to identify components in mixtures
- D** Review personal development of scientific skills for laboratory work.

## Summary of unit

Learning aim	Key content areas	Recommended assessment approach
<b>A</b> Undertake titration and colorimetry to determine the concentration of solutions	<b>A1</b> Laboratory equipment and its calibration <b>A2</b> Preparation and standardisation of solutions using titration <b>A3</b> Colorimetry	<p>Pro formas of results for checking the calibration of a pipette and balance(s) and calibration of a pH meter.</p> <p>A report on the use of <math>\text{Na}_2\text{CO}_3</math> to standardise HCl, used in turn to standardise NaOH. pH curve from the titration plus a differential plot.</p> <p>Results, calculations and calibration graph for the determination of the concentration of a coloured solution using colorimetry.</p> <p>Explanations of how the accuracy, precision and safety of the quantitative techniques may be optimised.</p> <p>Observation checklist, completed by the teacher, including safety.</p>
<b>B</b> Undertake calorimetry to study cooling curves	<b>B1</b> Thermometers <b>B2</b> Cooling curves	<p>Results from checking the calibration of at least two types of thermometer.</p> <p>A table of time/temperature data and a graph of temperature against time for a substance cooling.</p> <p>Calculations of the rate of cooling at points on the graph.</p> <p>An analysis of how the rate of cooling is related to intermolecular forces and the state of the substance.</p> <p>A report evaluating the accuracy of the cooling curve experiment.</p> <p>An observation report with a checklist, completed by the teacher, including safety.</p>
<b>C</b> Undertake chromatographic techniques to identify components in mixtures	<b>C1</b> Chromatographic techniques <b>C2</b> Application of chromatography <b>C3</b> Interpretation of a chromatogram	<p>Results from the paper chromatography and TLC of extracted plant pigments from paper chromatography of amino acids.</p> <p>An explanation of the principles behind the chromatographic separations.</p> <p>Suggestions for improvements to the chromatographic procedures carried out and full justification of these suggestions.</p> <p>An observation report with a checklist, completed by the teacher, including safety.</p>
<b>D</b> Review personal development of scientific skills for laboratory work	<b>D1</b> Personal responsibility <b>D2</b> Interpersonal skills <b>D3</b> Professional practice	<p>A presentation or report that focuses on the evaluation of learners' performance and skill development across all scientific procedures and techniques carried out in learning aims A, B and C.</p>

## Content

### Learning aim A: Undertake titration and colorimetry to determine the concentration of solutions

#### A1 Laboratory equipment and its calibration

Equipment and glassware used in titration and colorimetry and the importance and processes involved in calibration of measuring equipment.

- Use of pH meters and probes:
  - calibration according to the manufacturer's instructions.
- Use of balances and weighing:
  - electronic balances – rough balances (two decimal places), analytical balances (four decimal places)
  - checking calibration with certified weights
  - measurement of mass using increasingly accurate balances
  - suitable containers for weighing liquids and solids
  - density of water at different temperatures.
- Safe use of volumetric glassware:
  - bulb, graduated, automated and teat pipettes
  - burettes
  - glass and plastic filter funnels
  - volumetric flasks
  - accurate dilution
  - use of water as a standard for calibrating volumetric glassware.

#### A2 Preparation and standardisation of solutions using titration

Processes involved in the preparation and standardisation of solutions using titration.

- Accurate determination of the end-point of titrations from:
  - the colour change of a suitable indicator
  - plots of pH versus volume
  - $\Delta\text{pH}/\Delta\text{volume}$  versus volume.
- Calculation of concentrations:
  - use of molecular mass from periodic table.
- Use of primary and secondary titrimetric standards.

#### A3 Colorimetry

Understanding and practical application of colorimetry techniques.

- Selection and use of a colorimeter or visible spectrometer – selection of filter (colorimeter) or fixed wavelength (spectrometer).
- Measurement and use of absorbance readings.
- Use of Beer-Lambert law to determine the concentration of a transition metal ion solution.
- Accurate dilution of stock solutions to prepare a range of calibration standards with absorbance in the range 0 to 1.
- Use of blank solutions.
- Calibration plot.
- Determination of unknown solution concentration from reading from graph (graph paper) or from the equation of a linear trend line through the origin (Microsoft Excel).

**Learning aim B: Undertake calorimetry to study cooling curves****B1 Thermometers**

Types of thermometer, appropriate use and practical application of measurements of heat.

- The relationship between temperature and heat energy.
- Types of thermometer and how they are used to gain accurate readings:
  - electronic thermometers/temperature probes
  - liquid-filled thermometers.
- Checking the calibration of thermometers by using ice and boiling water.
- Accuracy of thermometers and temperature probes at different temperatures.

**B2 Cooling curves**

Construction and interpretation of cooling curves:

- temperature as a function of time
- rate of cooling from the gradient of the tangent to the cooling curve
- determination of melting point from the shape of a curve for a substance freezing
- super cooling
- shape of the curve and rate of cooling in relation to intermolecular forces and the state (solid or liquid) of the substance.

**Learning aim C: Undertake chromatographic techniques to identify components in mixtures****C1 Chromatographic techniques**

Theory, equipment and procedures used in chromatography.

- Terminology:
  - mobile and stationary phases
  - adsorption.
- Principles of paper chromatography.
- Principles of thin-layer chromatography (TLC):
  - nature of a TLC plate – glass, metal or plastic sheet with solid adsorbent layer.
- Use of capillary tubes to apply mixtures to paper or TLC plates.
- Choice of developing solvent and vessel.
- Preparative methods for samples:
  - solvent extraction
  - filtration
  - concentration by evaporation.
- The use of locating agents.

**C2 Application of chromatography**

- Separation of components of a mixture, to include plant pigments extracted from leaves/herbs with propanone (paper chromatography and TLC).
- Identification of unknown mixtures and pure substances using chromatography, to include amino acids (paper chromatography).
- Awareness of other types of chromatography – e.g. gas chromatography, ion-exchange chromatography – and that procedures and chromatogram interpretations are very different.

**C3 Interpretation of a chromatogram**

- Polarity of molecules/intermolecular forces in relation to solubility in the mobile phase.
- Polarity of molecules/intermolecular forces in relation to retention of molecules in the stationary phase.
- Size of molecules in relation to solubility and mobility.
- Calculation of R<sub>f</sub> value.
- Interpretation of chromatograms in terms of the number of substances present and the R<sub>f</sub> values of components.
- Awareness of common problems in technique resulting in difficulty interpreting a chromatogram, e.g. overloading samples, disturbing plate/paper during development or contamination of plate/paper.

**Learning aim D: Review personal development of scientific skills for laboratory work****D1 Personal responsibility**

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

- Work to appropriate standards and protocols.
- Application of safe working practices.
- Accept responsibility for the quality of own work.
- Take responsibility for completing tasks and procedures as well as using judgements within defined parameters.

**D2 Interpersonal skills**

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

- communication and co-operation in the scientific working environment
- give and receive constructive feedback
- behaviour for safe and efficient working in science.

**D3 Professional practice**

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

- recognise problems and apply appropriate scientific methods to identify causes and achieve solutions
- identify, organise and use resources effectively to complete tasks
- maintain and enhance competence.

## Assessment criteria

Pass		Merit	Distinction
<b>Learning aim A: Undertake titration and colorimetry to determine the concentration of solutions</b>			<b>A.D1</b> Evaluate the accuracy of procedures and techniques used in titration and colorimetry in relation to outcomes and suggest improvements.
<b>A.P1</b> Correctly prepare and standardise solutions for titration and colorimetry.	<b>A.P2</b> Investigate the concentration of unknown solutions, using procedures and techniques in titration and colorimetry.	<b>A.M1</b> Demonstrate skilful application of procedures and techniques in titration and colorimetry to accurately determine the concentration of solutions.	
<b>Learning aim B: Undertake calorimetry to study cooling curves</b>			<b>B.D2</b> Evaluate the accuracy of practical work in calorimetry in relation to the analysis of the cooling curve.
<b>B.P3</b> Correctly obtain data using different equipment to construct cooling curves.	<b>B.P4</b> Correctly determine the rate of cooling of substances using cooling curves.	<b>B.M2</b> Analyse the rate of cooling of substances from your data using cooling curves to draw valid conclusions.	
<b>Learning aim C: Undertake chromatographic techniques to identify components in mixtures</b>			<b>C.D3</b> Evaluate the chromatographic techniques used in relation to outcomes and suggest improvements.
<b>C.P5</b> Correctly use chromatographic techniques to produce chromatograms.	<b>C.P6</b> Explain the use of chromatographic techniques to separate mixtures.	<b>C.M3</b> Analyse own chromatograms and relate the factors that affect the separation of mixtures to the quality of results obtained.	
<b>Learning aim D: Review personal development of scientific skills for laboratory work</b>			<b>D.D4</b> Evaluate scientific skills developed in terms of potential for future progression.
<b>D.P7</b> Summarise key personal competencies developed in relation to scientific skills undertaken.		<b>D.M4</b> Analyse skills developed and suggest improvements to own practice.	

## Essential information for assignments

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

There is a maximum number of four 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)

Learning aim: D (D.P7, D.M4, D.D4)

## Further information for teachers and assessors

### Resource requirements

For this unit, learners must have access to:

- a well-equipped laboratory with a fume cupboard
- accurate balances
- a range of volumetric glassware
- pH meters, thermometers and temperature probes (access to data-logging software is useful but not essential)
- colorimeter or visible spectrometer
- chromatography paper, TLC slides
- a range of suitable chemicals, dependent on specific practical work that centres choose to utilise.

It is expected that where possible, appropriate investigative work will be carried out in this unit. Health and safety, and ethical considerations are paramount, and teachers must ensure that the necessary risk assessments are carried out and communicated to their learners. Refer to CLEAPSS and/or your centre's health and safety regulations if in doubt about any of the investigative work that has been suggested.

### Essential information for assessment decisions

#### Learning aim A

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

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

**For merit standard**, learners will undertake quantitative analytical procedures and techniques with minimal supervision, and perform to a high degree of accuracy and precision in order to obtain reliable and valid outcomes, with consideration for health and safety. Learners will demonstrate skill and fluency in a number of areas, such as: calibrating pipettes transferring solids, measuring volumes, mixing solutions, carrying out titrations and making the dilutions for colorimetry standards. They will be fully prepared in terms of equipment, reference material and consumables before attempting each step.

**For pass standard**, learners will follow instructions to safely undertake titration and colorimetry, although they may need to refer frequently to the instructions. These must be performed correctly to obtain reliable and valid outcomes. Learners will correctly carry out calculations of concentration.

For titration, learners will check the calibration of equipment used to ensure the validity of outcomes obtained (for example the calibration of a pipette, balances and a pH meter using buffer solutions). It is expected that learners will be assessed making a solution by weighing a solid, making the solution to volume and shaking to ensure that it mixes thoroughly. They could use a primary standard acid/base in a titration to standardise sodium hydroxide/hydrochloric acid prepared by the learner. Learners must also safely and correctly calibrate and use a colorimeter or visible spectrometer to determine the concentration of a coloured solution.

## Learning aim B

**For distinction standard,** learners will interpret outcomes of their calorimetry to make sound judgements on accuracy. Learners will be able to use appropriate mathematical terminology (for example rapid increase, decrease, approximately constant, etc.) to describe the patterns and trends in the shapes of cooling curves. They will be able to use the cooling curve of a substance to evaluate how close their values for the melting points are to literature and to class values, explaining where specific errors or problems with the given method or equipment may have led to inaccuracy. Learners could, for example, discuss the way in which the substance was cooled and the resulting changes to the curve. Learners will explain why it may be necessary to make changes to procedures in order to reduce levels of uncertainty.

**For merit standard,** learners will demonstrate selection of an appropriate amount of solid; selection of a suitable vessel for heating the solid, setting up the equipment to enable heating and cooling of the vessel in an appropriate way and monitoring temperature as a function of time in a safe way.

Learners will demonstrate numerical skills in graph plotting when constructing their cooling curve. These must include selecting the most appropriate scale, using appropriate labels including units, and drawing a smooth, best-fit curve through the points. By drawing tangents at appropriate points and finding their gradients, learners will correctly determine the rate of cooling near the start, end and where the rate appears to have changed dramatically in between. They will draw valid conclusions linking the rate of cooling to what is happening at a molecular level in terms of the positions and velocity of molecules and the forces between them. They will be able to explain which part of the graph corresponds to, for example, the melting point (freezing temperature).

**For pass standard,** learners will safely check the calibration of a given thermometer, following instructions. This could be done by using ice and boiling water. Learners will also explore the accuracy of the temperature measurements obtained from thermometers and other equipment by comparing their readings in water that is being heated. Learners will use a table of their own design for recording their readings. Learners will demonstrate key practical competencies in calorimetry, including being able to set up a vessel containing a solid, heating it to above its melting point, cooling it and measuring its temperature as a function of time, following a standard procedure.

Learners will plot graphs for a substance undergoing freezing. Learners might not select the most appropriate scale but will label axes correctly and draw a smooth curve through the points. They will accurately determine the rate of cooling near the start, demonstrating the ability to draw a tangent to the curve and find its gradient.

## Learning aim C

**For distinction standard,** learners will articulate strong links between outcomes and techniques used in order to give a rationale for specific improvements that could be made to the chromatographic techniques. They will articulate what would happen if a particular change were to be made. They will demonstrate awareness that some chromatograms may show the spots rising at an angle or have spots that are too big or smeared out rather than being distinct.

**For merit standard,** learners will demonstrate safe working practices and a high level of proficiency when carrying out paper- and thin-layer chromatography (TLC) with minimal supervision. They will produce chromatograms showing clear separation of spots, repeating the separations if they are not satisfied with the quality of the separation obtained. Learners will also comment on the suitability of the techniques for separation.

Learners will use appropriately calculated R<sub>f</sub> values and consider factors that influence separation to justify conclusions drawn about the identification of components in a mixture (for example the polarity of the components of the mixtures and the polarity of the solvents and effect of the size of a molecule on its mobility).

**For pass standard,** learners will follow instructions, demonstrating safe working practices and a good level of ability when carrying out paper and TLC. Learners will comment on the suitability of the techniques for separation and the chromatogram produced for each technique (TLC and paper chromatography). At this standard, the chromatograms may not produce spots showing an optimum degree of separation (for example the spots may be too large and lacking in distinction). They will determine R<sub>f</sub> values using paper chromatograms, using these to correctly identify components in a mixture.

### Learning aim D

**For distinction standard,** learners will draw upon all areas of practical work carried out to critically reflect on strengths and weaknesses of their own performance and skill development drawing on feedback, for example from peers, teachers and industry. Drawing on others' feedback is crucial for developing balanced progression goals.

**For merit standard,** learners will need to make judgements on their skill development and level in relation to their peer group. They will need to recognise the improvements that need to be made and how they will take steps to achieve them.

**For pass standard,** learners will identify areas of scientific skills developed in relation to the learning aims. They should draw on scientific skills they have previously acquired and use them to illustrate the transferability and development of skills.

### Links to other units

This unit links to:

- Unit 1: Principles and Applications of Science I
- Unit 3: Science Investigation Skills
- Unit 4: Forensic Investigation Procedures in Practice.

This unit also links to a wide range of optional units available across the qualification.

### Employer involvement

Centres may involve employers in the delivery of this unit if there are local opportunities. It would be beneficial for an industry representative to explain the importance of the routine calibration of equipment in ensuring the reliability of results. A visit to a local laboratory would reinforce the importance of calibration of equipment and health and safety. Even if the local organisations that use science only operate on a small scale, their representatives will be able to reinforce the importance of the transferable skills this unit develops.

# Unit 3: Science Investigation Skills

Level: **3**

Unit type: **External**

Guided learning hours: **120**

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## Unit in brief

Learners will cover the stages involved and the skills needed in planning a scientific investigation: how to record, interpret, draw scientific conclusions and evaluate.

## Unit introduction

Advancement in science and technology has produced great benefits for society. This advancement depends on research and investigative approaches in science and technology. In research, development, analytical and industrial laboratories, laboratory technicians and scientists are employed to safely carry out practical investigations, or follow prescribed laboratory procedures. They repeat measurements to obtain consistent, reliable results. They use investigative skills, including planning, recording and interpreting data, analysing and evaluating findings in order to test a hypothesis to inform further research and development.

In this unit, you will develop the essential skills underpinning practical scientific investigations. As well as drawing on *Unit 1* and *Unit 2*, these skills will be delivered through subject themes ranging from enzymes and diffusion to electrical circuits. The subject themes provide different contexts for the development of the investigative skills. To complete the assessment task within this unit, you will need to draw on your learning from across your programme.

Science investigative skills will help you in many scientific or enquiry-based learning courses in higher education, as well as prepare you for employment in a science-related industry.

## Summary of assessment

This unit will be assessed through a written task (Part B) worth 60 marks. The task is set and marked by Pearson and will be completed in one sitting, within a supervised assessment session timetabled by Pearson.

The assessment task will assess learners' ability to plan, record, process, analyse and evaluate scientific findings, using secondary information/data from scientific investigations related to the unit content.

In order to complete the written task in Part B, learners will be provided with Part A. Part A will outline the method/materials used to generate results/observations from a practical investigation.

Learners will have 45 minutes to review Part A before they complete Part B. Part B will be one session lasting one hour and 30 minutes. Both Part A and B will be under supervised conditions.

Part A and B are taken in a single session timetabled by Pearson.

The assessment availability is in January and May/June.

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

## Assessment outcomes

**AO1** Demonstrate knowledge and understanding of scientific concepts, procedures, processes and techniques and their application in a practical investigative context

**AO2** Interpret and analyse qualitative and quantitative scientific information to make reasoned judgements and draw conclusions based on evidence in a practical investigative context

**AO3** Evaluate practical investigative procedures used and their effect on the qualitative and quantitative scientific information obtained to make reasoned judgements

**AO4** Be able to make connections between different scientific concepts, procedures, processes and techniques to make a hypothesis and write a plan for a practical investigation

## Essential content

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

### A Planning a scientific investigation

#### A1 Developing a hypothesis for an investigation

- Be able to formulate a hypothesis or a null hypothesis based on relevant scientific ideas.

#### A2 Selection of appropriate equipment, techniques and standard procedures

- Be able to select and justify the use of equipment/techniques/standard procedures for quantitative and/or qualitative investigations.

#### A3 Health and safety associated with the investigation

- Understand risks and hazards associated with the investigation.

#### A4 Variables in the investigation

- Independent.
- Dependent.
- Control.

#### A5 Method for data collection and analysis

- Be able to produce a clear, logically ordered method to obtain results.
- Be able to select relevant measurements and the range of measurements to be recorded.
- Understand the importance of obtaining data accurately/reliably and to appropriate levels of precision.
- Understand how variables can be controlled/measured/monitored.
- Understand how the data/information can be analysed.

### B Data collection, processing and analysis/interpretation

#### B1 Collection of quantitative/qualitative data

- Be able to collect data accurately/reliably and to appropriate levels of precision.
- Be able to tabulate data in a clear and logical format using correct headings with units where appropriate.
- Be able to identify anomalous data and take appropriate action.
- Be able to recognise when it is appropriate to take repeats.
- Be able to make qualitative observations and draw inferences.

#### B2 Processing data

- Be able to carry out relevant calculations where appropriate, involving:
  - mean and standard deviation
  - use and interpretation of error bars
  - measuring gradients of a line and/or curve
  - use of statistical tests, including t-test, chi-squared and correlation analysis
  - use of formulae
  - transposition of formulae
  - conversion of units
  - use of standard form
  - percentage error of measuring equipment.
- Be able to display data in an appropriate format, including:
  - choosing an appropriate graph/chart/tables
  - correct plotting/labelling/scales.

## **C Drawing conclusions and evaluation**

### **C1 Interpretation/analysis of data**

- Be able to identify trends/patterns in data.
- Be able to compare primary and secondary data.
- Be able to use data to draw conclusions that are valid and relevant to the purpose of the investigation.
- Interpretation of statistical tests using tables of critical values and a 5% significance level, with reference to the null hypothesis.

### **C2 Evaluation**

- Be able to make any recommendations for improvements to the investigation.
- Be able to explain anomalous data.
- Be able to determine quantitative and discuss qualitative sources of error.
- Be able to discuss evidence of the reliability of the data collected during the investigation.
- Be able to identify strengths and weaknesses within method/techniques/standard procedures/equipment used.
- Be able to suggest improvements to an investigation.

## **D Enzymes in action**

### **D1 Protein structure**

- Peptide linkage.
- Active sites.
- Denaturation.

### **D2 Enzymes as biological catalysts in chemical reactions**

- Collision theory.
- Formation of enzyme-substrate complex.
- Specificity of enzymes.
- Lowering of activation energy.
- Importance of measuring initial rates of reaction.

### **D3 Factors that can affect enzyme activity**

- Temperature.
- pH.
- Substrate and enzyme concentration.

## **E Diffusion of molecules**

### **E1 Factors affecting the rate of diffusion**

- Concentration gradient.
- Shape and size of molecules.
- Temperature.
- Diffusion distance.
- Surface area – surface area to volume ratio.
- Energy of molecules.
- Membranes and barriers.

### **E2 Arrangement and movement of molecules**

- Random movement of molecules in liquids and gases.
- Little movement of molecules in solids.
- Diffusion down a concentration gradient until dynamic equilibrium is reached.

## **F Plants and their environment**

### **F1 Factors that can affect plant growth and/or distribution**

- Human effects – trampling, pollution, deforestation.
- Soil pH and aeration.
- Light intensity – shaded and unshaded areas.
- Temperature.
- Presence of water – moisture and rainfall.
- Mineral ions.
- Competition – intraspecific and interspecific.

### **F2 Sampling techniques**

- Understand the importance of random sampling in collecting reliable and valid data for analysis.
- Select appropriate ecological sampling techniques to investigate the effect of abiotic factors on plant populations, including:
  - transects
  - quadrats (open and gridded)
  - point frames.

### **F3 Sampling sizes**

- Select sample sizes for investigation with regards to practical constraints and the need to collect sufficient data to make valid conclusions.

## **G Energy content of fuels**

### **G1 Fuels**

- Alcohols – methanol, ethanol, propanol, butanol, pentanol.
- Foods – carbohydrates, lipids, protein.
- Hydrocarbons – petrol, paraffin, wax.

### **G2 Hazards associated with fuels**

- Flammability – risk of explosion.
- Toxicity – harmful effects of products of incomplete combustion.
- Pollution from sulfur impurities.

### **G3 Units of energy**

- Define – joules, kilojoules, calories, kilocalories.
- Heat capacity of water (will be given if required).
- Calculate heat energy supplied by a fuel to water using:
  - $\text{heat energy} = \text{mass of water} \times \text{specific heat capacity of water} \times \text{temperature rise of water}$ .
- Calculate heat energy released from a fuel in  $\text{kJ mol}^{-1}$ .

## H Electrical circuits

### H1 Use of electrical components in series and parallel circuits

- Cells, batteries, power packs.
- Ammeter.
- Voltmeter.
- Lamps.
- Resistors – thermistors, LDRs.
- Diodes – photodiodes, LEDs.

### H2 Equations

- Power = voltage  $\times$  current ( $P = I \times V$ ).
- Voltage = current  $\times$  resistance ( $V = I \times R$ )
- Power =  $\frac{\text{work done}}{\text{time}}$  ( $P = \frac{E}{t}$ )
- Energy = voltage  $\times$  current  $\times$  time ( $E = V \times I \times t$ ).

### H3 Energy usage

- Consider different domestic appliances to calculate energy usage.
- Relate fuse size to current.
- Energy transferred = power in kilowatts  $\times$  time in hours ( $kWh = kW \times h$ ).

## Grade descriptors

To achieve a grade a learner is expected to demonstrate these attributes across the essential content of the unit. The principle of best fit will apply in awarding grades.

### Level 3 Pass

Learners will demonstrate a sound knowledge and understanding of scientific concepts, procedures, processes and techniques and their application within a practical context. Learners will interpret and analyse secondary data, leading to reasoned judgements on the qualitative and quantitative data collected during an investigation. They will be able to draw links between different scientific concepts, procedures, processes and techniques to make a hypothesis and plan an investigation. Learners will be able to make evaluative judgements on scientific data, processes and procedures that make reference to scientific reasoning.

### Level 3 Distinction

Learners will demonstrate a thorough understanding of how scientific concepts, procedures, processes and techniques can be integrated and applied within a practical context. They will interpret, analyse and evaluate secondary data to support judgements and conclusions drawn. Learners will use and integrate knowledge and understanding of scientific concepts, procedures, processes and techniques to make a hypothesis and plan an investigation that is fully supported by scientific reasoning. Learners will be able to provide rationalised evaluative judgements on scientific data, processes and procedures that are fully supported by scientific reasoning.

## Key terms typically used in assessment

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

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

Only a single command word will be used per item.

Command or term	Definition
Add/label	Learners label or add to a stimulus material given in the question, for example labelling a diagram or adding units to a table.
Assess	Learners give careful consideration to all the factors or events that apply and identify which are the most important or relevant. Make a judgement on the importance of something, and come to a conclusion where needed.
Calculate	Learners obtain a numerical answer, showing relevant working. If the answer has a unit, this must be included.
Comment on	Learners synthesise a number of variables from data/information to form a judgement. More than two factors need to be synthesised.
Compare	Learners look for the similarities and differences of two (or more) things. Should not require the drawing of a conclusion. Answer must relate to both (or all) things mentioned in the question. The answer must include at least one similarity and one difference.
Complete	Learners complete a table/diagram.
Convert	Relates to unit conversion, for example g to kg.
Deduce	Learners draw/reach conclusion(s) from the information provided.

Command or term	Definition
Derive	Learners combine two or more equations or principles to develop a new equation.
Describe	Learners give an account of something. Statements in the response need to be developed as they are often linked but do not need to include a justification or reason.
Determine	Learners' answers must have an element which is quantitative from the stimulus provided, or must show how the answer can be reached quantitatively. To gain maximum marks there must be a quantitative element to the answer.
Discuss	Learners identify the issue/situation/problem/argument that is being assessed in the question. Explore all aspects of an issue/situation/problem argument. Investigate the issue/situation etc. by reasoning or argument.
Draw	Learners produce a diagram, either using a ruler or using freehand.
Estimate	Learners give a numerical value expected based on data given.
Evaluate	Learners review information then bring it together to form a conclusion, drawing on evidence including strengths, weaknesses, alternative actions, relevant data or information. Come to a supported judgement of a subject's qualities and relation to its context.
Explain	Learners' explanations require a justification/exemplification of a point. The answer must contain some element of reasoning/justification, this can include mathematical explanations.
Give/state/name	These generally require recall of one or more pieces of information.
Give a reason why	When a statement has been made and the requirement is only to give the reasons why.
Identify	Usually requires some key information to be selected from a given stimulus/resource.
Plot	Learners produce a graph by marking points accurately on a grid from data that is provided and then drawing a line of best fit through these points. A suitable scale and appropriately labelled axes must be included if these are not provided in the question.
Predict	Learners give an expected result.
Record	Specifically relates to devising a results table.
Show that	Learners prove that a numerical figure is as stated in the question. The answer must be to at least one more significant figure than the numerical figure in the question.
Sketch	Learners produce a freehand drawing. For a graph this would need a line and labelled axis with important features indicated. The axes are not scaled.
State and justify/identify and justify	When a selection is made and a justification has to be given for the selection.
State what is meant by	When the meaning of a term is expected but there are different ways in which this meaning can be described.
Write	When the question asks for an equation.

## Links to other units

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

- Unit 1 Principles and Applications of Science
- Unit 2 Practical Scientific Procedures and Techniques
- Unit 4 Laboratory Techniques and their Application
- Unit 5 Principles and Applications of Science II
- Unit 6 Investigative Project.

## Employer involvement

Centres may involve employers in the delivery of this unit if there are local opportunities. There is no specific guidance related to this unit.



# Unit 4: Forensic Investigation Procedures in Practice

Level: **3**

Unit type: **Internal**

Guided learning hours: **90**

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## Unit in brief

Learners develop techniques in collecting, analysing and reporting chemical, physical and biological evidence during forensic investigations.

## Unit introduction

In this unit, you will develop an understanding of the importance of health and safety, and the need for objectivity and justification in your approach to identifying and analysing forensic evidence. You will investigate a simulated crime scene and demonstrate appropriate forensic procedures in collecting and packaging forensic evidence.

You will develop scientific analytical-thinking skills through the use of biological, chemical and physical evidence. You will remain impartial, develop a chronology and provide scientific justification for analysis, presenting facts from investigations in a non-biased manner. This unit requires you to explore practically the principles of science that form the basis of some of the analytical techniques commonly used, as well as to carry out analysis on forensic evidence. It also requires you to interpret the results and report valid conclusions. To complete the assessment task within this unit, you will need to draw on your learning from across your programme.

The range of procedures, concepts and scientific practical skills developed throughout this unit will help you progress to a variety of courses in higher education in this sector.

## Learning aims

In this unit you will:

- A** Explore procedures used to preserve, collect and record forensic evidence from a simulated crime scene
- B** Use analytical techniques to examine forensic evidence collected from a simulated crime scene
- C** Draw conclusions and report on the results of the analysis of forensic evidence.

## Summary of unit

Learning aim	Key content areas	Recommended assessment approach
<p><b>A</b> Explore procedures used to preserve, collect and record forensic evidence from a simulated crime scene</p>	<p><b>A1</b> At the crime scene  <b>A2</b> Procedures used to preserve, recover and record forensic evidence  <b>A3</b> Health and safety</p>	<p>Learners should preserve and process a mock scene and produce crime scene notes with photographs of their evidence. This should be supported with an observation document, completed by the assessor. Learners should produce a written report that demonstrates understanding of how to gather forensic evidence.</p>
<p><b>B</b> Use analytical techniques to examine forensic evidence collected from a simulated crime scene</p>	<p><b>B1</b> Biological evidence and biological analysis  <b>B2</b> Chemical evidence and chemical analysis  <b>B3</b> Physical evidence and analysis  <b>B4</b> Rationalising analytical techniques</p>	<p>Learners should produce a portfolio of laboratory examination forms, including drawings and photographs where appropriate, method sheets and results of analysis. This should be supported with an observation document, completed by the assessor.</p>
<p><b>C</b> Draw conclusions and report on the results of the analysis of forensic evidence</p>	<p><b>C1</b> Interpretation of evidence  <b>C2</b> Presentation of analysis on forensic evidence</p>	<p>An appropriately structured expert witness statement should be produced that includes results, explanations and aspects of probability.</p>

## Content

### Learning aim A: Explore procedures used to preserve, collect and record forensic evidence from a simulated crime scene

#### A1 At the crime scene

- Scientific support at the crime scene – role of crime scene investigators (CSIs).
- Authorised personnel at the scene – first attending officer (FAO), CSI, crime scene manager, police officers, paramedics, fire and rescue service officers, forensic scientists.
- Who – victim, perpetrator, witnesses.
- When – timeline.
- Where – internal crime scene (house, vehicle, building), external crime scene (lake, park, woodland), public place, private place.
- What – motive, modus operandi, evidence may have been left.

#### A2 Procedures used to preserve, recover and record forensic evidence

- Restriction of the scene and restriction of access:
  - police tape, vehicles, police officers, forensic tents
  - cordon log.
- Observation and recording of the scene, identifying and targeting evidence:
  - crime scene notes (contemporaneous notes), videography, photography, sketches.
- Search patterns:
  - quadrant
  - lane
  - grid
  - spiral
  - wheel.
- Limiting contamination.
- Documenting trace materials:
  - scene of crime documentation, e.g. crime scene notes, sketches and photographs, evidence labels (CJA – Criminal Justice Act labels).
- Recovery of trace materials:
  - methods of collection – casting, swabbing, tweezers, taping, shaking, brushing and vacuuming
  - marks and impressions.
- Characterisation and comparison of evidence.
- Packaging and labelling, to include paper bag versus plastic bag and evidence tubes.
- Storage and transport of a variety of materials while preserving the integrity of the evidence.
- Continuity of evidence.
- Route of evidence: CSI, Scientific Support Unit (SSU), forensic laboratory, court.

#### A3 Health and safety

- Health and Safety at Work etc. Act 1974 and subsequent updates.
- Control of Substances Hazardous to Health (COSHH) Regulations 2002.
- Management of Health and Safety at Work Regulations 1999.
- Use of disposable personal protective equipment (PPE).

(Statutes and regulations current at the time of teaching should be used. Outline understanding only is expected in terms of how CSIs must adhere to them, for example when identifying hazards and planning to control the hazard.)

## **Learning aim B: Use analytical techniques to examine forensic evidence collected from a simulated crime scene**

### **B1 Biological evidence and biological analysis**

- Biological evidence – evidence that once belonged to a living or once living organism:
  - blood
  - saliva
  - semen
  - fingerprints
  - hair (human and animal)
  - bones.
- Biological evidence allows a perpetrator to be individualised.
- Biological analysis:
  - blood group analysis
  - genetics (DNA sequencing, profiling)
  - latent fingerprints enhancement and visual examination (patterns, minutiae and ridge counting)
  - hair identification and analysis – microscopy
  - bone and skeletal physiology
  - control samples
  - reference material.

### **B2 Chemical evidence and chemical analysis**

- Chemical evidence – evidence that contains chemicals:
  - drugs – Class A, B and C
  - poisons, e.g. anions, corrosive poisons, gaseous and volatile poisons, metal and metalloid poisons, pesticides and toxins, volatiles
  - gunshot residue (GSR) test
  - specimens for ante-mortem and post-mortem toxicology investigation (e.g. blood, urine, vitreous humour, liver and stomach contents).
- Chemical analysis:
  - chromatography – separation of mixtures, e.g. paper, column, thin layer (TLC), gas (GC), high performance liquid (HPLC)
  - mass spectrometry – spectrometric technique
  - spectroscopy, e.g. infrared (IR), ultraviolet (UV), visible (colorimetry)
  - chemical presumptive tests – bodily fluids (blood, semen, saliva) e.g. marquis test for drugs and poisons, modified Griess test, dermal nitrate test, sodium rhodizonate test
  - chemical enhancement – fingerprints (e.g. ninhydrin, silver nitrate, iodine, amido black and cyanoacrylate fuming)
  - control samples.

### **B3 Physical evidence and analysis**

- Physical evidence – evidence that has not come from a living or once living organism and does not contain chemicals:
  - ballistics, e.g. rifling, ballistic profiling, propellants, micro stamping, calibre wound patterns, trajectory
  - footwear, e.g. oblique lighting, casting, electrostatic lifting, gel lifting, visual analysis and comparison
  - toolmarks – casting
  - documents, e.g. handwriting (cursive, printing and signatures), printed documents (typewriters, photocopiers, laser printers, ink jet printers), paper, ink
  - IT, e.g. mobile phones, computers, tablets, GPS, CCTV
  - fibre – identification and analysis – microscopy.

- Analysis of physical evidence:
  - visual examination
  - microscopy and comparison microscopy
  - control samples
  - reference materials.

#### **B4 Rationalising analytical techniques**

- Reasons for selection of analytical technique.
- Advantages and drawbacks of analytical technique.
- Precision – how reproducible a result is.
- Accuracy – how near a given measurement is to the true value.
- Error – expression of inaccuracy:
  - personal error
  - instrumental error
  - method error.

### **Learning aim C: Draw conclusions and report on the results of the analysis of forensic evidence**

#### **C1 Interpretation of evidence**

- Present unbiased results and measurements, including units.
- Qualitative and quantitative data.
- Draw conclusions from observations of circumstances of the crime scene.
- Justification for conclusions.
- Unbiased expert opinion.
- Probability of validity.

#### **C2 Presentation of analysis on forensic evidence**

- Court case file preparation.
- Expert witness written statement/report:
  - name and date of birth (DOB)
  - occupation
  - details of expert's qualifications and relevant experience
  - receipt and description of items received, including exhibit number
  - a statement of the facts received by the forensic expert before analysis
  - purpose of the examination
  - details of scientific literature relied on when making the report
  - who carried out the examination, measurements/tests the expert has made conclusions on and whether this was done under direct supervision
  - details of the analysis carried out
  - results of the analysis/examination
  - interpretation of the results gained from the analysis in context with the criminal case
  - conclusions, expression of expert opinion based on fact
  - expression of significance/probability of the evidence in the case linked to purpose based on a scale; no, little, moderate, moderately strong, strong, very strong and extremely strong.

## Assessment criteria

Pass		Merit	Distinction
<b>Learning aim A: Explore procedures used to preserve, collect and record forensic evidence from a simulated crime scene</b>			<b>A.D1</b> Evaluate the importance of using appropriate procedures to preserve, collect and record forensic evidence.
<b>A.P1</b> Describe the procedures used to preserve, collect and record forensic evidence.	<b>A.M1</b> Justify the choice of procedures used to preserve, collect and record forensic evidence.		
<b>A.P2</b> Select appropriate procedures to preserve, collect and record forensic evidence.			
<b>Learning aim B: Use analytical techniques to examine forensic evidence collected from a simulated crime scene</b>			<b>B.D2</b> Evaluate the analytical techniques used in forensic science to examine biological, chemical and physical forensic evidence.
<b>B.P3</b> Describe the analytical techniques used to examine biological, chemical and physical forensic evidence.	<b>B.M2</b> Justify the choice of the analytical techniques used to examine biological, chemical and physical forensic evidence.		
<b>B.P4</b> Select appropriate analytical techniques to examine biological, chemical and physical forensic evidence.			
<b>Learning aim C: Draw conclusions and report on the results of the analysis of forensic evidence</b>			<b>C.D3</b> Produce a detailed and coherent forensic expert witness statement/report, showing clear scientific reasoning to draw valid conclusions.
<b>C.P5</b> Produce a correctly structured forensic expert witness statement/report, with findings from the analysis of evidence.	<b>C.M3</b> Produce a coherent forensic expert witness statement/report, with interpretation of the findings from the analysis of evidence.		

## Essential information for assignments

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

There is a maximum number of three 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

This unit aims to develop learners' skills in investigative and analytical techniques in the context of practical science. It is therefore important that learners have access to facilities to carry out practical scientific work for demonstration and practice.

It is important to introduce learners to the rigorous nature of scientific investigations. They should also be introduced to the importance of comprehensive documentation and the objective reporting of results. Learners should have ample opportunity to practise and develop their skills in these areas.

It is expected that where possible, appropriate investigative work will be carried out in this unit. Health and safety, and ethical considerations are paramount, and teachers must ensure that the necessary risk assessments are carried out and communicated to their learners. Refer to CLEAPSS and/or your centre's health and safety regulations if in doubt about any of the investigative work that has been suggested.

For this unit, teachers should select and use appropriate simulated forensic samples, where appropriate, for learners to investigate, that adhere to health and safety practices in place at the centre.

### Essential information for assessment decisions

#### Learning aim A

**For distinction standard**, learners will discuss the significance of continuity, chain of evidence and appropriate documentation procedures. They will also discuss health and safety measures and their importance in preserving the integrity of evidence for forensic analysis. Their evaluation will include the advantages of using appropriate procedures to preserve, collect and record forensic evidence from a crime scene, and the problems that may arise from not using them.

**For merit standard**, learners must justify the methods used and why they are important to preserve, collect and record forensic evidence from a crime scene. They should demonstrate health and safety awareness and an excellent standard of evidence recovery. Learners should recover evidence using the most appropriate collection method, selecting the most suitable packaging to ensure contamination is limited. Learners should produce detailed crime scene notes to explain why each procedure was carried out and relate it to maintaining the integrity and continuity of the evidence.

**For pass standard**, learners will examine a simulated crime scene and demonstrate a clear understanding of the evidence collection techniques and procedures used when preserving and processing a crime scene. Learners must demonstrate an awareness of the importance of health and safety through a risk assessment. When collecting forensic evidence, learners must select appropriate collection and packaging methods in order to demonstrate and maintain the integrity of forensic evidence. They must also demonstrate awareness of other relevant procedures, paying particular attention to limiting contamination. Learners must collect at least two biological pieces of forensic evidence, for example a bloodstained T-shirt and hairs, two chemical pieces of forensic evidence, for example a gun with gunshot residue (GSR) and drugs, and two physical pieces of forensic evidence, for example a footprint and bullet cartridge. Learners should produce crime scene notes and take photographs of the scene and evidence.

### Learning aim B

**For distinction standard**, learners will evaluate the advantages and disadvantages of using each analytical technique. Learners should discuss cost, ease of use, transportability of equipment, subjectivity of result, decreased yields, damage to forensic evidence and speed of result. Learners should reflect on and evaluate their own practical method used to analyse two biological and two chemical pieces, as well as two physical pieces of forensic evidence. They will discuss reliability and validity of results and accuracy. They should suggest improvements to the analytical techniques they carried out.

**For merit standard**, learners will explain the theory behind the analytical techniques carried out to justify why the analysis was suitable to be used on different pieces of forensic evidence. They should explain how the tests work in order to produce results for interpretation.

**For pass standard**, learners will select appropriate analytical techniques to analyse two biological, two chemical and two physical pieces of forensic evidence that they collected from the simulated crime scene. They need to carry out practical work independently, making sure results are reliable, accurate and valid. Learners should produce forensic evidence examination forms to document their analysis and results.

### Learning aim C

**For distinction standard**, learners will need to consider probability in terms of possible, probable and likely. The expert's opinion is designed to give the members of the court a probable or most likely explanation of the evidence to assist the court in reaching their decision. For example, the DNA profile of an unknown blood sample at a crime scene is compared to the DNA profile of a suspect and the profiles match. The forensic expert would state the probability ratio of a match and the chances of someone else having the same profile as the blood left at the crime scene using statistical analysis and literature.

**For merit standard**, learners will interpret their results in relation to their simulated crime scene and draw valid scientific conclusions, with evidence and scientific reasoning. Learners will give a clear and logical justification for the conclusions drawn and comment on its significance and any subsequent analysis that could be carried out.

**For pass standard**, learners must produce an expert witness statement/report to present in court. The report should include the purpose of each examination carried out, an indication of the results gained and an interpretation of these results relating to the crime.

### Links to other units

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

- Unit 1: Principles and Applications of Science I
- Unit 2: Practical Scientific Procedures and Techniques
- Unit 3: Science Investigation Skills
- Unit 5: Applications of Criminology
- Unit 6: Criminal Investigation Procedures in Practice
- Unit 7: Applications of Criminal and Forensic Psychology.

### Employer involvement

This unit would benefit from employer involvement in the form of:

- visiting speakers, including a forensic expert in the field of study
- visits to a forensic laboratory to understand how evidence can be analysed.



# Unit 5: Applications of Criminology

Level: **3**

Unit type: **External**

Guided learning hours: **120**

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## Unit in brief

Learners examine selected theories of criminology that are used to explain, measure and tackle crime and criminal behaviour in England and Wales.

## Unit introduction

Criminology is the study of crime and criminal behaviour, drawing on psychology, sociology, law, and other disciplines to explain the causes and prevention of crime. In this unit, you will study how different aspects of criminology help us to understand the reasons why some people may commit crimes and the various methods of crime prevention in England and Wales.

There are many different approaches to defining and explaining the extent of crime in England and Wales. You will determine why, according to criminological theories, certain groups are more likely to commit crime than others. You will look at differences between the various sets of crime statistics that explain crime and criminal behaviour. You will also look at the impact of crime on society, focusing on how the media can shape our perception of crime, as well as determining what may influence the likelihood of an individual being a victim of crime. This unit will also look at the theories underlying methods of crime prevention and the different punishment methods used for those convicted of a crime.

This unit has a vocational emphasis and gives a basis for further studies in criminology and criminal justice, forensic psychology and other related higher education courses. It also prepares you for a broad range of employment opportunities such as in the police, probation or prison service, criminal justice agencies, volunteering and victim support agencies.

## Summary of assessment

This unit is assessed under supervised conditions. Learners will be given a task book containing the assessment activities and information related to the activities. Learners will be expected to read through the information as it will form the basis for the focus of the assessment.

The supervised assessment must be completed in a single morning session of 3 hours timetabled by Pearson. Pearson sets and marks the task.

The number of marks for the unit is 60.

The assessment availability is December/January and May/June each year. The first assessment availability is January 2019.

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

## Assessment outcomes

**AO1** Demonstrate knowledge and understanding of the criminological theories used to explain criminal behaviour, crime prevention and punishment methods, and the impact of crime on society

**AO2** Apply knowledge and understanding of criminological theories and information provided to explain criminal behaviour, crime prevention and punishment methods, and the impact of crime on society

**AO3** Be able to rationalise and make reasoned decisions based on interpretation and analysis of information and synthesis of knowledge and understanding

## Essential content

The essential content is set out under content areas. Learners must cover all specified content before the assessment. They must understand and recognise the basic principles of all the topics. Learners will need to have basic understanding of theories outlined in the content, be able to evaluate them and apply them to contexts. They will not be expected to have a detailed understanding of any named studies but an understanding of the aims, findings and application.

### A The nature of crime

#### A1 Types of crime and crime statistics

- Types of crime:
  - different categorisations of crime – volume crime, major crime; classifications of crime – summary, indictable, triable either way, crimes against the person, crimes against property, cybercrime.
- Interpretation and analysis of the different types of crime statistics:
  - Home Office official statistics
  - self-report victim surveys – Crime Survey for England and Wales (CSEW), Commercial Victimization Survey (CVS)
  - self-report offender surveys.

#### A2 General theoretical explanations as to why people commit crime

- Functionalist theories:
  - Durkheim – inevitability of crime and positive functions of crime
  - Merton – strain theory.
- Realist theories:
  - left realism – relative deprivation, subculture, marginalisation
  - right realism – biological differences, socialisation and the underclass, rational choice theory.
- Marxist theories:
  - traditional Marxism – criminogenic capitalism and crime as a response to the capitalist system, law-making serving the interests of the capitalist state, selective enforcement
  - Neo-Marxism – critical criminology and crime as a voluntary act with a political motive.
- Postmodernist theories:
  - individualism
  - culture of resentment.

#### A3 Specific theoretical explanations related to the social distribution of crime

- Gender and crime:
  - patterns and trends of offending between the sexes over the last 50 years
  - theoretical explanations of why women appear to commit less crime than men – sex-role theory, the gender and class deal, patriarchal control
  - growing female criminality – changing gender roles and 'ladette' culture
  - masculinity and crime – hegemonic masculinity, subordinated masculinity.
- Age and crime:
  - patterns and trends of offending according to age group over last 50 years
  - theoretical explanations for links between age and crime – status frustration, peer group status and focal concerns of lower working classes, delinquency, drift and neutralisation.

- Social class and crime:
  - patterns and trends in offending according to class over the last 50 years
  - theoretical explanations for the links between social class and crime – social deprivation, strain theory and anomie, marginality, social exclusion and control and rational choice theory
  - white collar crime – explaining white collar crime and the under-representation of white collar crime.
- Ethnicity and crime:
  - patterns of offending according to ethnic group over the last 50 years
  - theoretical explanations for links between ethnicity and crime – relative deprivation, marginalisation and subculture, Neo-Marxism and the myth of black criminality – Gilroy (1982).
- Locality and crime:
  - patterns and trends of offending in urban and rural areas according to crime statistics
  - theoretical explanations for the links between locality and crime – the Chicago School and the 'zone of transition' by Shaw and McKay (1931, 1942); Croydon study by Morris (1957); Sheffield study by Baldwin and Bottoms (1976).

## **B Crime prevention and punishment**

### **B1 Methods of crime prevention**

- Right realist methods of crime prevention:
  - situational crime prevention
  - environmental crime prevention.
- Left realist methods of crime prevention:
  - social and community crime prevention.
- Postmodernist methods of crime prevention:
  - private crime prevention techniques
  - localised and community-based policing policies.

### **B2 Punishment**

- Perspectives on punishment:
  - functionalist perspective – Durkheim and retributive and restitutive justice
  - Marxist perspective – function of punishment as maintaining social order
  - postmodernist perspectives on punishment – Foucault's sovereign and disciplinary power.
- Aims of sentencing:
  - aims of adult sentencing – incapacitation, rehabilitation, deterrence, retribution, reparation, denunciation, reducing the crime rate
  - aims in youth sentencing – reform and rehabilitation, punishment, protecting the public, reparation.
- Types of sentences:
  - adult sentences – custodial sentences, community orders, fines
  - youth sentences – Young Offender Institutions (YOIs), detention and training orders, detention for serious crimes, detention at Her Majesty's Pleasure, Youth Rehabilitation Order (YRO), fines.

## **C The impact of crime on society**

### **C1 The media and crime**

- Social construction of crime by the media:
  - news values – risk, immediacy, dramatization, personalisation, higher status persons, novelty or unexpectedness, violence, simplification
  - representation of social groups – gender, age, locality, social class, ethnicity, labelling and its effects
  - representation of types of crime.
- Media as a contribution to fear of crime – deviancy amplification spiral, moral panics.

### **C2 Victims of crime**

- Patterns of victimisation – class, age, ethnicity, gender, repeat victimisation.
- Perspectives on victims of crime:
  - positive victimology – factors that produce patterns in victimisation, interpersonal crimes of violence, contribution of the victim to victimisation, including victim proneness
  - critical victimology – structural factors that make a person more at risk of being a victim of crime, state's power to apply or deny the label of victim.
- Impact of victimisation – direct impact, secondary victimisation, fear of crime, indirect impact.

## Grade descriptors

To achieve a grade learners are expected to demonstrate these attributes across the essential content of the unit. The principle of best fit will apply in awarding grades.

### Level 3 Pass

Learners will demonstrate an understanding of criminological theories used to explain criminal behaviour. They will demonstrate application of understanding by identifying the aims of sentencing and suggesting a suitable type of sentencing and crime prevention methods to the given scenario, making references to appropriate theories. Learners will be able to apply their understanding of victims of crime and make links to the article(s) to give reasons why an individual is a victim of crime and the impact it has on them. Learners will be able to analyse and interpret articles and select relevant evidence to support judgements made on the impact of the media on the fear of crime.

### Level 3 Distinction

Learners will demonstrate a thorough understanding of criminological theories used to explain criminal behaviour in the arguments they articulate and will justify their judgements. They will continuously draw links to relevant information in theories to justify the aims and type of sentencing and crime prevention methods they have suggested. Learners will be able to give a rationalised judgement as to why an individual in the given article(s) would be a victim of crime and the impact it has on them, using evidence from criminological theories to support their judgements. Learners will be able to critically interpret and analyse articles in the scenario in order to make valid judgements to support discussions on the impact of the media on the fear of crime.

## Key words typically used in assessment

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

Command or term	Definition
Assess	Learners give careful consideration to all the factors or events that apply and identify which are the most important or relevant. Make a judgement on the importance of something, and come to a conclusion where needed.
Discuss	Learners identify the issue/situation/problem/argument that is being assessed in the question. Explore all aspects of an issue/situation/problem/argument. Investigate the issue/situation etc by reasoning or argument.
Explain	Learners' work shows clear details and gives reasons and/or evidence to support opinions, views or arguments. It could show how conclusions are drawn (arrived at). Learners show that they comprehend the origins, functions and objectives of a subject, and its suitability for purpose.

## Links to other units

This unit links to:

- Unit 4: Forensic Investigation Procedures in Practice
- Unit 6: Criminal Investigation Procedures in Practice
- Unit 7: Applications of Criminal and Forensic Psychology.

This unit also links to a wide range of optional units available across the qualification.

## Employer involvement

Centres can involve employers in the delivery of this unit if there are local opportunities to do so. There is no specific guidance related to this unit.



# Unit 6: Criminal Investigation Procedures in Practice

Level: **3**

Unit type: **Internal**

Guided learning hours: **90**

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## Unit in brief

Learners study the legal framework, criminal law and techniques used during criminal investigation. Learners develop communication skills and experience while giving evidence in a mock trial.

## Unit introduction

In this unit, you will develop an understanding of the Criminal Justice System (CJS), including the police and courts. You will cover the legal framework that criminal investigators must work to in order to protect individual rights, as well as the adversarial system where prosecution and defence set out evidence in court to determine guilt or innocence.

It is important that investigators know the tools available to them and make use of the most appropriate resources. You will learn about interviewing techniques that, when used well, can draw out intelligence for the police to act on. You will look at the wide range of tools, skills and powers that can be used by investigators. Criminal investigations can range from minor crimes to major incidents but the procedures to be followed must be equally rigorous in all cases. If the evidence collected by the police or other investigating service is not secure and reliable, the defendant may be acquitted, even if guilty. This illustrates the importance of rigorous criminal investigation procedures. In order for you to appreciate how to collect reliable and secure material evidence, this unit looks at the principles developed to minimise the risk of an innocent person being found guilty or the guilty being acquitted. You will have an opportunity to present interview evidence just as a professional witness such as a police officer/criminal investigation department (CID) officer would. To complete the assessment tasks within this unit, you will need to draw on your learning from across your programme.

The range of procedures, concepts and skills developed throughout this unit will help you progress to a variety of degree courses in higher education in this sector.

## Learning aims

In this unit you will:

- A** Understand the legal framework that criminal law investigators must adhere to in order to secure a criminal conviction
- B** Explore procedures and the resources available in criminal investigations
- C** Develop communication skills as a professional witness in a mock criminal trial.

## Summary of unit

Learning aim	Key content areas	Recommended assessment approach
<p><b>A</b> Understand the legal framework that criminal law investigators must adhere to in order to secure a criminal conviction</p>	<p><b>A1</b> Criminal court system  <b>A2</b> Legal framework  <b>A3</b> Criminal law</p>	<p>Learners must research and outline the legal framework that investigators must follow in order to secure a criminal conviction.</p>
<p><b>B</b> Explore procedures and the resources available in criminal investigations</p>	<p><b>B1</b> Stages involved from crime scene to court  <b>B2</b> Resources available to the investigating team  <b>B3</b> Interviewing techniques to obtain intelligence evidence</p>	<p>Learners should produce a written report that demonstrates understanding of the stages of a criminal investigation and the resources available to them to gather evidence. Learners should demonstrate interview skills to obtain information from suspects. The results should be recorded electronically or documented in a report.</p>
<p><b>C</b> Develop communication skills as a professional witness in a mock criminal trial</p>	<p><b>C1</b> Courtroom layout  <b>C2</b> Mock courtroom criminal trial procedure and preparation  <b>C3</b> Communication skills in the courtroom</p>	<p>Learners will demonstrate communication skills by taking part in a mock trial courtroom experience. They will use their interview evidence and produce a witness statement to present in court. They will act as a professional witness. The centre should provide robust evidence of learners' mock trial cross-examination, which should include video, audio or observation records/transcript testimony.</p>

## Content

### Learning aim A: Understand the legal framework that criminal law investigators must adhere to in order to secure a criminal conviction

#### A1 Criminal court system

- Level and type of criminal investigation.
- National Police Chiefs Council (NPCC) guidelines.
- Criminal and civil offences.
- Role of CJS agencies in criminal investigations.
- Magistrates' courts.
- Crown court.
- Appeals – High Court, the Court of Appeal and Supreme Court.

#### A2 Legal framework

- Current legislation relating to criminal investigations, e.g. the Police and Criminal Evidence (PACE) Act 1984.
- Stop and search.
- Arrest.
- Detention.
- Investigation.
- Identification.
- Interviewing detainees.

#### A3 Criminal law

(Statutes and regulations current at the time of teaching should be used. Outline understanding only is expected in terms of how investigators may adhere to these.)

- Types of offences: against the person, against property, against public order.
- Actus reus: act, omission, voluntary, causation.
- Mens rea: intention, recklessness, negligence.
- Burden of proof.

Current legislation in:

- Criminal justice.
- Prosecution of offences.
- Misuse of drugs.
- Sexual offences.
- Criminal procedures and investigations.
- Youth justice and criminal evidence.
- Regulation of investigatory powers (RIPA).
- Criminal procedure (Amendment) rules.
- Human rights.
- Data protection.
- Freedom of information.

## **Learning aim B: Explore procedures and the resources available in criminal investigations**

### **B1 Stages involved from crime scene to court**

- Initial response to reported crime.
- Preliminary and follow-up investigations.
- Standard operating procedures and regulation.
- Report writing and presentation of evidence in court.
- Incident room set up by police when they are dealing with a major crime or accident.
- Investigating leads and different lines of enquiry.
- Researching and analysing intelligence systems.
- Gathering and analysing evidence.
- Witness statements.
- Database records.
- CCTV analysis.
- Surveillance, informants and intelligence systems.
- Written, tape and DVD recorded interviews.
- Forensic evidence.
- Identifying patterns and links.
- Process of elimination.
- Ethical considerations, including confidentiality.
- Use of press, media and other CJS agencies.
- Evaluation and interpretation of evidence in context of the specific criminal case.

### **B2 Resources available to the investigating team**

- Technical aids:
  - bugs
  - cameras
  - electronic facial ID software
  - forensic gait analysis
  - Automatic Number Plate Recognition (ANPR)
  - Police National Computer (PNC).
- Electoral register.
- Social media sites.
- Profiling techniques.
- Surveillance technique devices:
  - CCTV
  - phone tapping
  - communications data surveillance
  - interception of communication
  - traffic data surveillance.
- Sources of information:
  - intelligence databases:
    - Police National Computer (PNC), Home Office Large Major Enquiry System (HOLMES), National Ballistics Intelligence Service (NABIS), National Automated Fingerprint Identification System (NAFIS), National DNA Database, Driver and Vehicle Licensing Agency (DVLA) database, Motor Insurers' Bureau (MIB)
  - criminal records
  - crime statistics
  - reports, crime and autopsy toxicology
  - recorded 999 calls
  - personal records, telephone, financial and mobile data and records
  - biometric data – keystroke or typing recognition, speaker recognition, hand or finger geometry recognition, facial recognition.

**B3 Interviewing techniques to obtain intelligence evidence**

- Interviewees: victim, suspect/offender statements, witness testimony, vulnerable witnesses, e.g. elderly, young, disabled, non-English speaking, professional experts.
- Interviewer: dealing with the public, preparation of location, e.g. police station, home.
- Interview conduct: tape recording, DVD recording.
- Types of evidence: corroborative, circumstantial, hearsay evidence, eyewitness testimony.
- PEACE model of interviewing: Planning and Preparation; Engage and Explain; Account, Clarification and Challenge; Closure; Evaluation.
- Types of interviews and interrogation techniques: interview models, non-verbal, observation and communication skills, criminal investigation interview, cognitive interview, use of open and closed questions, inappropriate use of force, multiple-choice questions, leading or misleading questions, models of memory, false confessions, detecting deception.
- Factors affecting eyewitness testimony: attention, perception, reconstructive memory, stress and arousal, encoding information.
- Impact of additional information about the crime – media, other witnesses, police.

**Learning aim C: Develop communication skills as a professional witness in a mock criminal trial****C1 Courtroom layout**

- Crown court.
- Magistrates' courts.
- Crown court personnel: judge, jury, prosecution barrister, defence barrister, press, public, defendant, usher, clerk, witness.

**C2 Mock courtroom criminal trial procedure and preparation**

- Pre-trial conference.
- Preparation before the trial: witness statement.
- Reviewing material again.
- Case file is annotated and indexed.
- Punctuality.
- Evidence presented in sequence.
- Witness box.
- Under oath or affirmation.
- Magistrates addressed as 'Your Worship'.
- Crown court judges addressed as 'Your Honour' or 'My Lord'.
- Witness must present name, work address, qualifications and work experience.
- Examination-in-chief.
- Cross-examination.
- Answering techniques – brief, accurate answers.
- Re-examination.
- Releasing the witness.
- Debriefing session.
- Presentation of evidence must be accurate, reliable, clear and easily understood.

**C3 Communication skills in the courtroom**

- Communication – confident, persuasive, succinct.
- Communicate clear ideas and intentions.
- Use vocational language and terminology.
- Verbal communication: pace, format, structure, tone, interaction, professional practice, e.g. when addressing judge/magistrates.
- Non-verbal: silence, listening, gestures, posture, eye contact, facial expressions.

## Assessment criteria

Pass		Merit	Distinction
<b>Learning aim A: Understand the legal framework that criminal law investigators must adhere to in order to secure a criminal conviction</b>			<b>A.D1</b> Evaluate the importance of investigators adhering to appropriate legal framework and criminal law.
<b>A.P1</b> Explain the criminal court system, legal framework and criminal law that criminal investigators must adhere to.	<b>A.M1</b> Discuss the legal framework and criminal law that criminal investigators must adhere to.		
<b>A.P2</b> Describe examples of crime in terms of mens rea and actus reus.			
<b>Learning aim B: Explore procedures and the resources available in criminal investigations</b>			<b>B.D2</b> Evaluate the stages of the investigation process, including interviewing and the resources available during a criminal investigation.
<b>B.P3</b> Explain the stages of an investigation process and the resources available during an investigation process.	<b>B.M2</b> Discuss the importance of the stages of the investigation process and the resources available during a criminal investigation.		
<b>B.P4</b> Demonstrate appropriate interview skills using techniques to gain intelligence information.	<b>B.M3</b> Compare the methods of interviewing used to gain intelligence information.		
<b>Learning aim C: Develop communication skills as a professional witness in a mock criminal trial</b>			<b>C.D3</b> Demonstrate confident, disciplined and organised communication skills as a professional witness in a mock criminal trial.
<b>C.P5</b> Demonstrate appropriate communication skills as a professional witness in a mock criminal trial.	<b>C.M4</b> Demonstrate effective communication skills as a professional witness in a mock criminal trial.		

## Essential information for assignments

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

There is a maximum number of three 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.M3, B.D2)

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

## Further information for teachers and assessors

### Resource requirements

This unit aims to develop learners' skills in investigative and criminal procedures. It is therefore important that learners have access to facilities to carry out research on the internet.

It is important to introduce learners to the rigorous nature of investigations. They should also be introduced to the importance of comprehensive documentation and the objective reporting of evidence. Learners should have ample opportunity to practise and develop their skills in these areas.

### Essential information for assessment decisions

#### Learning aim A

**For distinction standard**, learners will evaluate the importance of adhering to the legal framework during the stages of a criminal investigation in order to secure a successful prosecution. For example, when stopping and searching a person, PACE Code A gives police officers the powers to stop and search without first making an arrest. It must be used fairly and responsibly and they must respect the person being searched. The intrusion must be brief and carried out in the proper manner. If this did not occur then the search would be deemed illegal, it could hinder the investigation and any evidence seized would potentially be inadmissible in court.

**For merit standard**, learners will discuss why the legal framework is put in place to help secure a criminal conviction, protecting the officers and suspects. Learners should use legislation current at the time of teaching. Learners are required to give only an outline of their understanding and they should explain the framework in terms of how it helps ensure a successful prosecution.

**For pass standard**, learners will give an explanation of the current legal framework that is put in place to ensure a criminal conviction is sound. Learners are required to describe at least three different examples of crime and how both the actus reus and mens rea are necessary for the suspect to be guilty of a criminal offence.

#### Learning aim B

**For distinction standard**, learners must evaluate all the stages of the investigation process. The evaluation should include the impact of effectively carrying out procedures compared to the impact of when stages are not executed efficiently and accurately. Learners should conclude the overall impact this may have on the criminal investigation. Learners should compare and contrast the resources available during a criminal investigation, including advantages and disadvantages of resources used, giving examples where possible.

**For merit standard**, learners will discuss the importance of each stage of a criminal investigation and the resources available to secure a successful conviction. Learners must compare the use of different methods for interviewing in terms of the suitability and importance during a criminal investigation and they should give examples of when different techniques may be used.

**For pass standard**, learners will explain all the stages involved in an investigation and they should describe how all the resources could be used during an investigation. Learners should provide examples of when these resources could be used. Learners must take part in a mock interview where they will plan their own interview questions based on a given scenario or seen witness statement. They should demonstrate interview skills and interview a suspect or witness, recording their findings.

## Learning aim C

Assessors should take on the role of the criminal defence barrister, cross-examining learners who are taking on the role of professional witness such as a senior investigating officer. The assessor should cross-examine and challenge learners on their findings from their interview. Assessors must ensure that learners not being assessed are not present during the cross-examination of other learners, ensuring the assessment process is fair to all learners.

**For distinction standard**, learners will demonstrate excellent knowledge in their interview by giving a confident presentation of their findings. They will not make reference to their prepared witness statement during the examination. They will use confident, disciplined and organised communication skills in listening, reasoning and speaking, and will respond quickly during the cross-examination to provide comprehensive evidence.

**For merit standard**, learners will demonstrate effective knowledge in their interview and witness statement by giving an effective presentation of their findings. They will make occasional reference to their witness statement while being examined. They will use effective communication skills in listening, reasoning and speaking, and will respond quickly during the cross-examination.

**For pass standard**, learners will demonstrate knowledge of their interview evidence by presenting their interview findings. Learners must produce a witness statement that reports the findings from their interview. They will make considerable reference to the witness statement while giving their evidence in the mock trial courtroom. They will use appropriate communication skills in verbal and non-verbal listening, reasoning and speaking.

## Links to other units

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

- Unit 1: Principles and Applications of Science 1
- Unit 2: Practical Scientific Procedures and Techniques
- Unit 3: Science Investigation Skills
- Unit 4: Forensic Investigation Procedures in Practice
- Unit 5: Applications of Criminology.

## Employer involvement

This unit would benefit from employer involvement in the form of visiting speakers, including a police officer with experience of being involved with criminal investigations.

If feasible, centres could arrange for learners to attend a court hearing to understand how evidence may be given.



# Unit 7: Applications of Criminal and Forensic Psychology

Level: **3**

Unit: **External**

Guided learning hours: **120**

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## Unit in brief

Learners examine how different aspects of criminal and forensic psychology are applied in the Criminal Justice System (CJS).

## Unit introduction

There are many different explanations commonly offered to account for criminal and antisocial behaviour. The explanations you will learn about in this unit are split into two broad areas: those which have their basis in biology and those which come from personality, social learning and behavioural approaches. These different approaches are often referred to as the nature/nurture debate. You will apply the two broad perspectives to help explain why individuals commit crime.

Forensic psychologists work in different ways in the CJS and you will develop your understanding of selected aspects of this work. An important area of forensic psychology involves working directly with convicted offenders. You will develop your understanding of commonly used treatments for convicted offenders and consider their effectiveness. Offender profiling supports the police in solving crime by identifying potential suspects. You will explore ways in which offenders are profiled and you will develop knowledge about how to profile potential suspects based on crime-scene evidence. To complete the assessment task within this unit, you will need to draw on your learning from across your programme.

This unit places an emphasis on forensic psychology in a vocational setting and gives you the opportunity to develop your understanding of the work of a forensic psychologist. This will be useful as a basis for further study in fields such as psychology, forensic psychology, criminology and criminal justice in higher education. This unit will also help you to progress to employment in different roles in the CJS, or to a career working directly with people in education, social care, youth work and counselling.

## Summary of assessment

This unit is assessed under supervised conditions. Learners will be given a task book containing the assessment activities and information related to the activities. Learners will be expected to read through the information as it will form the basis for the focus of the assessment.

The supervised assessment must be completed in a single morning session of 3 hours timetabled by Pearson. Pearson sets and marks the task.

The number of marks for the unit is 60.

The assessment availability is December/January and May/June each year. The first assessment availability is January 2019.

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

## Assessment outcomes

**AO1** Demonstrate knowledge and understanding of psychological ideas, concepts and approaches in criminal and forensic psychology

**AO2** Application of knowledge and understanding of psychological ideas, concepts and approaches in criminal and forensic psychology through case studies and scenarios

**AO3** Analyse and evaluate information related to case studies and scenarios underpinned by ideas, concepts and approaches in criminal and forensic psychology to make supported judgements

**AO4** Be able to create an offender profile underpinned by psychological ideas, concepts and approaches and in context, with justification

## Essential content

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

Learners will consider real-life research, case studies and the named work of psychologists relevant to the three areas of application. Learners must understand and recognise the basic principles of all the topics. Learners will not be expected to have a detailed understanding of the named studies but an understanding of the aims and findings of the studies and how these contribute to the work of the criminal and forensic psychologist in the selected areas relevant to this unit. Learners are expected to draw on knowledge and understanding from content in units across the qualification when completing the assessment task.

### A Psychological perspectives applied to criminal behaviour

#### A1 Biologically based approaches

- Genes – the effect of the extra Y chromosome in some males:
  - male aggression
  - lack of empathy
  - XYY syndrome (super-male syndrome)
  - case study on Theilgaard – *A psychological study of the personalities of XYY- and XXY-men* (1984), the validity of the extra Y chromosome explanation, aims/findings
  - the warrior gene – variation of the X chromosome gene: production of the monoamine oxidase (MAOA) enzymes
  - the effect of MAOA on neurotransmitters dopamine, norepinephrine and serotonin.
- Twin studies – evidence supporting the link between genetics and criminality:
  - identical and non-identical twin studies supporting the genetic link with criminality
  - the work of Christiansen in Denmark – *Preliminary Study of Criminality Among Twins (Biosocial Bases of Criminal Behavior, 1977)* – study of 3586 pairs of identical and non-identical twins and the genetic link to criminality, aims and findings.
- Neurotransmitters and brain function:
  - neurotransmitters and how these affect behaviour – serotonin and dopamine levels and how they impact on behaviour and aggression
  - effects of amphetamine and alcohol use on behaviour.
- Brain injury – the relationship between offending behaviours and brain injury caused by:
  - accident or illness
  - long-term alcohol use
  - drug abuse.
- Hormonal links with offending behaviour:
  - gender differences in testosterone levels and offending types and rates
  - elevated testosterone levels in males aged 15–25 and incidences of aggression and violent behaviour
  - anabolic steroids and the link to violent acts.

#### A2 Personality approaches

- Personality traits and criminal behaviour:
  - Eysenck – individual differences: extroversion, introversion, neuroticism, stability and psychoticism
  - arousal theory – introverts/extroverts
  - PEN personality model and its link to criminal behaviours as used by Eysenck.

- Personality disorders (PD):
  - narcissistic – the need for admiration and the ability to exploit others
  - antisocial – ignoring others and aggressive behaviour
  - paranoid – distrust of others and bearing grudges
  - the aims and findings from the work of Michael Stone in his published book: *Personality-Disordered Patients: Treatable and Untreatable* (2007).

### **A3 Social learning approaches**

The influence of social learning factors in understanding criminal behaviour:

- family patterns – family size, parental occupation
- maternal deprivation and parenting
- friendship groups
- named study – Bowlby– *Forty-four Juvenile Thieves: Their Characteristics and Home-life* (1946), aims and findings
- superior and inferior groupings
- identity formation
- stereotyping of groups
- Madon – *Self-fulfilling Prophecies: The Synergistic Accumulative Effect of Parents' Beliefs on Children's Drinking Behaviours* (2004), aims/findings.

### **A4 Behavioural approaches**

Modelling behaviours by observing other people:

- observation of offender activities first-hand
- media presentation of criminal activity – presentation of 'good guys' and 'bad guys'
- vicarious self-reinforcement – after seeing others commit crime and reap the rewards of criminal behaviour
- choosing to commit crime.

## **B Offender profiling**

### **B1 Introduction to offender profiling**

- Aims of profiling:
  - narrowing down suspects
  - predicting future crimes – when and where
  - giving clues to the police on useful interview techniques.
- Common features related to the crime scene:
  - type of victim
  - special features associated with the crime committed
  - location
  - time – day or night
  - frequency of the crime committed
  - what is taken and what is left behind.
- Criminal consistency:
  - the way the crime is committed
  - the individual habits of the offender
  - spatial consistency
  - consistency of the offender behaviour pattern – preferred ways of acting.
- Profiling features:
  - age
  - sex of offender
  - marital status
  - occupation
  - intellectual ability
  - possible crime history

- area where criminal lives
- ethnicity
- religion
- culture
- social class.

## **B2 Behavioural evidence analysis profiling**

Crime scene investigation:

- statistical profiling
- use of statistics to help identify the offender
- identifying different aspects of the potential offender's profile
- patterns of crime linked to offender characteristics
- examination of crime scene records to identify offender's behaviours
- geographical profiling/small-space analysis – city zones, routine activity theory, spatial location of serial crimes
- strengths and weaknesses of using offender profiles in police work
- named study – Rossmo – *Geographic Profiling* (2000), aims and findings
- David Canter – John Duffy case study.

## **C Treatment approaches used with offenders**

### **C1 Cognitive therapy**

- Aim – to change the way the offenders react in future situations.
- Underlying approach taken in the treatment – understanding thoughts and feelings, appreciating distorted thinking and the effect of this on actions.
- Treatment process – restructuring faulty thinking patterns, counselling, enabling, mindfulness.
- The aims and findings in the work of Beck – *Prisoners of Hate: The Cognitive Basis of Anger, Hostility, and Violence* (1999).
- Effectiveness of treatment.

### **C2 Anger management programmes**

- Aim – to change the psychological response to anger.
- Underlying approach taken in treatment – restructure thought patterns.
- Treatment process – cognitive preparation, skills acquisition, application practice, time-out, assertiveness training, role play, anger diaries, small group, ten sessions.
- Named study – Howells et al. – *Brief anger management programmes with offenders: Outcomes and predictors of change* (2005), aims and findings.
- Effectiveness of treatment.

### **C3 Behavioural treatments**

- Aim – change the way offenders interact with others.
- Underlying approach taken in treatment – social skills training, assess current interaction pattern, develop positive social skills to use in current and future situations.
- Treatment process – enhanced thinking skills, improving decision-making and problem-solving skills, assertiveness training.
- Named study – Hollin, McGuire et al. – *Cognitive Skills Behaviour Programs for Offenders in the Community: A Reconviction Analysis* (1995), aims and findings.
- Effectiveness of treatment.

#### **C4 Hormone and drug treatments**

- Aim – to address hormonal imbalances and change behaviour.
- Underlying approach taken in treatment – assess current levels of dopamine, serotonin and testosterone.
- Treatment process – change in the levels of serotonin, dopamine and testosterone through drug treatment programmes.
- Named study – Le Blanc et al. – *Risperidone reduces aggression in boys with a disruptive behaviour disorder and below average intelligence quotient: analysis of two placebo-controlled randomized trials* (International Clinical Psychology, 2005) aims and findings.
- Effectiveness of treatment.

#### **C5 Diet**

- Aim – to supplement diet to change behaviour.
- Underlying approach taken in treatment – assess vitamin and mineral deficiencies, assess blood sugar levels.
- Treatment process – diet changes, diet supplementation.
- Case study – Gesch et al. – *Influence of supplementary vitamins, minerals and essential fatty acids in the antisocial behaviour of young male prisoners* (2002), aims and findings.
- Effectiveness of treatment.

## Grade descriptors

To achieve a grade learners are expected to demonstrate these attributes across the essential content of the unit. The principle of best fit will apply in awarding grades.

### Level 3 Pass

Learners demonstrate sound knowledge and understanding of psychological ideas, concepts and approaches and can apply them to contexts given in the case study. They will be able to apply understanding of psychological approaches to propose and rationalise a treatment programme that has relevance to the scenario. Learners will be able to create an offender profile and rationalise its importance to the police through analysis and evaluation of psychological information given. Learners will interpret and analyse psychological information to draw links between the scenario, information and different psychological ideas, concepts and approaches.

### Level 3 Distinction

Learners will demonstrate accurate and comprehensive knowledge and understanding of psychological ideas, concepts and approaches, and can fully apply them/can make sustained links to contexts given in the case studies. They will create a treatment programme that shows clear links to the scenario, with fully supported justifications of why that treatment programme is most effective, demonstrating knowledge and understanding of psychological approaches. Learners will be able to interpret and analyse psychological information to create a detailed offender profile and provide rationalised evaluative judgement of its importance to the police, supported by reasoning and with awareness of limitations. Learners will critically interpret, analyse and evaluate information in order to make valid judgements to support discussions.

## Key words typically used in assessment

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

Command or term	Definition
Offender profiling	A method used to identify potential suspect(s) to support work of a criminal investigator.
Treatment approach	One method of approach used.
Treatment programme	A range or combination of treatment approaches used.

## Links to other units

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

- Unit 1: Principles and Applications of Science I
- Unit 2: Practical Scientific Procedures and Techniques
- Unit 3: Science Investigation Skills
- Unit 4: Forensic Investigation Procedures in Practice
- Unit 5: Applications of Criminology
- Unit 6: Criminal Investigation Procedures in Practice.

## Employer involvement

Centres can involve employers in the delivery of this unit if there are local opportunities to do so. There is no specific guidance related to this unit.

# Unit 8: Physiology of Human Body Systems

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

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## Unit in brief

Learners will focus on the physiological make up of three human body systems (musculoskeletal, lymphatic and digestive), how the systems function and what occurs during dysfunction.

## Unit introduction

The human body is a complex mix of organs and organ systems. Knowledge of how they function to maintain human life is an essential part of the study of human physiology. In this unit, you will focus on three body systems: musculoskeletal, lymphatic and digestive. You will examine each of the systems as a functioning unit, identifying their structure and function. By exploring the anatomy of these systems, through experimentation and use of simulations, you will develop your knowledge and understanding of their role in the human body.

You will also give attention to understanding the implications of what happens when the systems fail to work properly and the available treatments. The unit will be of particular interest if you are interested in sport, body-building and maintaining a healthy body.

An understanding of the fundamental systems that make up the human body is a key requirement if you wish to progress to study forensic science related courses, health and care-related programmes or biomedical sciences in further education and at university. It is an essential requirement for a career in sport- and health-related disciplines, for example physiotherapist, sport trainer and exercise physiologist.

## Learning aims

In this unit you will:

- A** Understand the impact of disorders of the musculoskeletal system and their associated corrective treatments
- B** Understand the impact of disorders on the physiology of the lymphatic system and the associated corrective treatments
- C** Explore the physiology of the digestive system and the use of corrective treatments for dietary-related diseases.

## Summary of unit

Learning aim	Key content areas	Recommended assessment approach
<p><b>A</b> Understand the impact of disorders of the musculoskeletal system and their associated corrective treatments</p>	<p><b>A1</b> Structure of the musculoskeletal system</p> <p><b>A2</b> Function of the musculoskeletal system</p> <p><b>A3</b> Health matters and treatments related to the musculoskeletal system</p>	<p>Learners would use information gained from research, visits, dissections/videos, models and simulations to produce an illustrated report explaining and analysing the structure and function of the musculoskeletal system.</p> <p>An evaluation of a related disorder/dysfunction of the system and associated treatments must be included.</p>
<p><b>B</b> Understand the impact of disorders on the physiology of the lymphatic system and the associated corrective treatments</p>	<p><b>B1</b> Structure of the lymphatic system</p> <p><b>B2</b> Function of the lymphatic system</p> <p><b>B3</b> Health matters and treatments related to the lymphatic system</p>	<p>Research work using the internet and TV documentaries to help learners to create a presentation that describes and explains the structure and function of the lymphatic system in promoting a healthy body.</p> <p>An evaluative case study of the effect of a disorder/dysfunction of the system and possible treatments must be included.</p>
<p><b>C</b> Explore the physiology of the digestive system and the use of corrective treatments for dietary-related diseases</p>	<p><b>C1</b> Structure of the digestive system</p> <p><b>C2</b> Function of the digestive system</p> <p><b>C3</b> Health matters and treatments related to the digestive system</p>	<p>A lab book/record of investigations modelling the functioning of the various parts of the digestive system. Photographs and information from the investigations will be used to create an information leaflet that explains the role and location of organs and evaluates dietary disorder in the system and possible treatments.</p> <p>Observation records of practical work undertaken to assess the nutrient content of food will be required. Evidence and conclusions from the investigations will be incorporated into the information leaflet.</p>

## Content

### Learning aim A: Understand the impact of disorders of the musculoskeletal system and their associated corrective treatments

#### A1 Structure of the musculoskeletal system

Structure and identification of major bones, muscles, joints and supporting apparatus by visual examination of diagrams or models and manipulative means in living subjects as appropriate.

- Axial skeleton, to include:
  - cranium, mandible and maxilla
  - vertebral column (cervical, thoracic and lumbar vertebrae, sacrum and coccyx, intervertebral discs)
  - ribs and sternum.
- Appendicular skeleton, to include:
  - limb bones (humerus, radius, ulna; femur, patella, tibia, fibula)
  - wrist, hand and digit bones (carpals, metacarpals, phalanges)
  - ankle, foot and digit bones (tarsals, metatarsals, phalanges, calcaneus)
  - shoulder girdle (scapula, clavicle)
  - pelvic girdle (ilium, pubis, ischium).
- Bone types: long bones, short bones, flat bones, irregular bones, sesamoid bones.
- Bone composition: periosteum, spongy/compact bone, bone marrow, mineral use.
- Identification of the major joint types and where they exist in the human body – gliding, condyloid, saddle, socket, ball and socket, pivot, hinge.
- Classification of joints: fibrous, cartilaginous, synovial.
- Composition and location of ligaments and tendons.
- Major muscle groups.
- Structure of muscle fibres.

#### A2 Function of the musculoskeletal system

Functions of each part of the musculoskeletal system and how each contributes to the effective functioning of the whole system.

- Skeletal functions: support, protection, attachment for skeletal muscle, storing minerals, producing blood cells, maintaining mineral homeostasis.
- Muscle: the role of ligaments, tendons, skeletal muscle, smooth muscle, process of muscle contraction, fast- and slow-twitch fibres.
- Movement due to interaction of muscles, bones, joints and attachment apparatus: flexion/extension, adduction/abduction, internal/external, rotation, circumduction.

#### A3 Health matters and treatments related to the musculoskeletal system

The causes, symptoms and common treatments involved in common disorders or dysfunction in the musculoskeletal system.

- Disorders to include: forms of arthritis; hip dysplasia; hypermobility; bone fracture and dislocation; repetitive strain injury (RSI); muscle, ligament and tendon trauma.
- Treatments for musculoskeletal disorders (including physiological reasoning behind the treatment), to include: physiotherapy; arthroscopy; joint replacement therapy; rest, ice, compression, elevation (RICE); splinting and casting.

## **Learning aim B: Understand the impact of disorders on the physiology of the lymphatic system and the associated corrective treatments**

### **B1 Structure of the lymphatic system**

Composition and location of component parts:

- spleen, thymus gland, tonsils, lymph glands, lymph vessels
- major lymph nodes – axillary, abdominal, inguinal, popliteal, supratrochlear
- presence of valves.

### **B2 Function of the lymphatic system**

Location, processes, structures involved and importance of each function:

- formation and transport of lymphocytes and lymph
- removal of interstitial fluid from tissues
- maintenance of hydrostatic pressure
- absorption of fats from the digestive system.

### **B3 Health matters and treatments related to the lymphatic system**

Symptoms, treatment and physiological reasoning behind treatment for disruption or dysfunction of the lymphatic system, to include:

- lymphadenitis
- lymphedema
- Hodgkin's lymphoma.

## **Learning aim C: Explore the physiology of the digestive system and the use of corrective treatments for dietary-related diseases**

### **C1 Structure of the digestive system**

Location and structural features of the following parts of the digestive system and associated organs:

- mouth, pharynx, oesophagus, stomach, small intestine (duodenum, jejunum, ileum), large intestine, rectum, anus
- associated organs: pancreas, liver, gall bladder.

### **C2 Function of the digestive system**

- Processes involved in digestion, absorption and assimilation of nutrients:
  - mechanical and chemical digestion
  - action of enzymes (protease, amylase, lipase, hydrolysis and assimilation)
  - sites of nutrient absorption, active transport, diffusion.
- Chemical tests for the presence of macro-nutrients found in foods: starch, proteins, lipids, reducing and non-reducing sugars, vitamin C content.

### **C3 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, e.g. coeliac disease, irritable bowel syndrome, colitis.

## Assessment criteria

Pass		Merit	Distinction
<b>Learning aim A: Understand the impact of disorders of the musculoskeletal system and their associated corrective treatments</b>			<b>A.D1</b> Evaluate the effect of corrective treatment(s) associated with a musculoskeletal disorder.
<b>A.P1</b> Explain the functional role of the musculoskeletal system in the human body.  <b>A.P2</b> Describe the effect of disorder of muscles and joints and possible corrective treatment(s).	<b>A.M1</b> Compare how disorders of the musculoskeletal system can affect how muscles bring about movement of joints and the role of corrective treatment(s).		
<b>Learning aim B: Understand the impact of disorders on the physiology of the lymphatic system and the associated corrective treatments</b>			<b>B.D2</b> Evaluate the effect of corrective treatment(s) for a disorder of the lymphatic system.
<b>B.P3</b> Describe the gross anatomy and function of the organs of the lymphatic system.  <b>B.P4</b> Describe the effect of a disorder on the lymphatic system and possible corrective treatment(s).	<b>B.M2</b> Explain the physiological reasoning for corrective treatment(s) associated with a disorder of the lymphatic system.		
<b>Learning aim C: Explore the physiology of the digestive system and the use of corrective treatments for dietary related diseases</b>			<b>C.D3</b> Evaluate the effect of dietary disease and corrective treatment(s) on human health.
<b>C.P5</b> Explain the role and location of organs involved in digestion.  <b>C.P6</b> Correctly carry out investigations to establish sources and importance of key nutrients for a balanced diet.  <b>C.P7</b> Describe the symptoms of nutrient deficiency as a result of dietary-related disease.	<b>C.M3</b> Analyse the role of digestive enzymes on nutrient uptake in each part of the digestive system.  <b>C.M4</b> Explain the use of corrective treatment(s) for nutrient deficiency.		

## Essential information for assignments

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

There is a maximum number of three 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.P7, C.M3, C.M4, C.D3)

## Further information for teachers and assessors

### Resource requirements

For this unit, learners must have access to:

- a well-equipped laboratory
- IT resources, which could be used as a reference point.

It is expected that where possible, appropriate investigative work will be carried out in this unit. Health and safety, and ethical considerations are paramount, and teachers must ensure that the necessary risk assessments are carried out and communicated to their learners. Refer to CLEAPSS and/or your centre's health and safety regulations if in doubt about any of the investigative work that has been suggested.

### Essential information for assessment decisions

It is understood that specific groups of learners or teachers for ethical, religious or other reasons may feel that they are not able to undertake dissection work as part of the unit. If practical dissection is not carried out, it is expected that suitable alternatives will be available. This is to enable learners to fully understand the anatomy and physiology of the body systems studied in the unit content. Alternatives to dissection could be documentaries of dissections/operations, computer-generated simulations and model making.

### Learning aim A

**For distinction standard**, learners will research disorders/dysfunctions of the musculoskeletal system. Learners will reach conclusions based on referenced evidence they have produced from research on the impact on health of one named disorder/dysfunction and its corrective treatment(s). A visit from or to a physiotherapist would aid understanding and help create a vocational context.

Learners will provide a detailed evaluation demonstrating in-depth, scientific knowledge of the anatomy and physiology of the effects of the condition, including major bones, muscle (groups), joints and movement at the joints. Learners will then establish how the disorder impacts the normal functioning/movement in the human body.

Learners will evaluate how the work of the medical professional uses corrective mechanisms and treatments in order to improve the functioning of the skeleton and its physical, physiological and social impact on human health. Learners will also explain the limitation of the corrective treatment(s) used.

**For merit standard**, learners must provide a detailed comparison of three disorders affecting different aspects of the musculoskeletal system and how normal movement is affected. Learners must use the correct scientific and technical terms to clearly outline the type of joint, muscle movement at the joint, muscle attachment and the groups of muscles that are involved in bringing about normal movement. They must also explain the importance of the movement to the normal functioning of the human body and how each disorder differs in terms of its effect on normal function. When comparing corrective treatments for each disorder, learners must consider scientific rationale for using that particular treatment over others.

Access to dissection of a small mammal, chicken bones/joints, or models of skeletons and joints and use of simulations would develop and aid learners' understanding. The use of referenced diagrams or photographs to help learners to produce an analytical report on muscles, joints and associated movement should be encouraged. Correct use of scientific terms must be included in the report.

**For pass standard,** learners will explain how the structure of the human skeleton, muscles and joints form an essential system in the functioning of the human body by providing support, protection, movement and storage/production of minerals and blood cells. Learners will identify and name six major joints in the human musculoskeletal system and fully explain the importance of their structure and role in the human body in terms of normal movement. Learners will name one disorder of musculoskeletal system and outline how it impacts normal function of the human body. Learners will reference specific muscles or muscle groups and joints affected by the disorder and give an overview of the corrective treatment(s) associated with it.

### Learning aim B

**For distinction standard,** learners must base their evaluation on one named disorder. They will analyse the effect of the disease on the lymphatic system, the normal functioning of which will be explicitly explained. The implications of the disease on the health status of an individual suffering from the disorder will be addressed within the context of a patient case study. Learners will evaluate the physiological basis of any treatment and discuss the impact of this on the restoration of normal lymphatic function. This will include benefits and problems faced by medical professionals when using corrective treatments. They will use correct scientific terminology throughout.

**For merit standard,** learners will demonstrate detailed understanding of the anatomy and function of the lymphatic system, using correct scientific terminology to explain the rationale for use of corrective treatment for the effects of a named disorder of the lymphatic system. Learners will give detailed explanations of the disorder affecting the normal functioning of the lymphatic system and the associated corrective treatment.

**For pass standard,** learners must describe the gross anatomy of the organs and associated structures that form the lymphatic system. Learners must label (for themselves) each structure of the lymphatic system and describe, in brief, the role it plays in the system. Learners will describe how lymph is formed and its role in the health of the body.

Learners will also briefly describe a named disorder and its effect on the normal function of the lymphatic system, including the symptoms present in the human body and give an overview of the corrective treatment(s) associated with the disorder.

### Learning aim C

**For distinction standard,** learners will research dietary-related disorders of the digestive system. Learners must choose a named digestive system-related disease that affects the normal functioning of the body. They must explain how the named disease affects the system using correct biological terminology. Learners must also consider the effects on the person that is suffering from the disease and how medical intervention seeks to treat the effects of disease. Evaluations must also cover the implications to the health status of the individual and compare this with the healthy functioning of the digestive system.

**For merit standard,** learners must analyse the mode of action of digestive enzymes as applied to each of the macronutrients listed in the unit content. This will include named enzymes, the location of enzyme secretion, the location of enzyme action (if different), substrates and products of each nutrient broken down with enzymatic assistance. This will be linked to the analysis of nutrients in foods.

Learners will need to consider how nutrient deficiency can be tackled in terms of corrective treatments. They must explain the corrective treatment for the deficiency of two nutrients and how they may relieve the symptoms described.

**For pass standard,** learners must perform analytical tests to identify the nutrients present in dietary sources of macronutrients as listed in the unit content, they must also give detailed descriptions of nutrient-deficiency symptoms. Learners must describe the gross anatomy of the different areas of the digestive system as listed in the unit content. Learners should label each of the areas of the digestive system and describe, in brief, the role of the component labelled. Learners could use photographs from the dissection to label or complete a dissection. This would help provide the context necessary to help generate the understanding required.

## Links to other units

This unit links to:

- Unit 1: Principles and Applications of Science I
- Unit 13: Forensic Genetics
- Unit 14: Forensic Anthropology and Archaeology.

## Employer involvement

University sports science departments may be able to provide support and guidance and access to models of joints and a skeleton. Physiotherapy departments may be able to offer information and access to examples of replacement joints and exercises that will assist in treatment and recovery from musculoskeletal dysfunction.

GP Surgeries may have specialist nurses who might be available to visit and provide information about management of digestive system disorders, such as coeliac disease, irritable bowel syndrome and colitis.



# Unit 9: Environmental Forensics

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

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## Unit in brief

Learners study the use of environmental forensics in crime, covering the study of taphonomy and the main methods used in collecting and analysing entomological, soil, pollen and diatom evidence.

## Unit introduction

Environmental forensics (also known as forensic ecology) is used in forensic investigation, especially for using entomological evidence to estimate time of death (TOD). Other scientific disciplines such as botany, ecology and geology are now also being recognised as forms of forensic assistance in solving crimes as diverse as wildlife crime to serious crimes such as murders, where they are used to search for potential body disposal sites and linking suspects to the victim or crime scene. This environmental evidence helps to build intelligence data that can be used to bring new leads and connections to major serious criminal investigations. New techniques of recovering traces of drugs and DNA from human remains, via the larvae feeding on the body, are also being used.

In this unit, you will understand and appreciate the importance of environmental forensics in forensic investigation. The main evidence types covered will be entomology, pollen (palynology), diatoms (which are a type of algae) and soil. You will learn the stages of decomposition with the study of taphonomy (the science of decomposition) and appreciate how entomological processes can affect this. You will gain knowledge of the processes in estimating the TOD using taphonomy and entomological techniques. You will also have an opportunity to explore soil, pollen and diatom evidence. You will gain skills and knowledge in scene sampling and laboratory methods of analysis.

This unit will be useful in applying for higher education courses, especially for forensic science courses containing significant environmental content. A science degree in this area could lead to employment with the police or to forensic work as a scene of crime officer or forensic scientist, as well as potential employment in such areas as the environment and wildlife, pest control, local government and revenue and customs.

## Learning aims

In this unit you will:

- A** Understand how concepts in taphonomy and entomology contribute to forensic investigation
- B** Carry out investigative techniques for taphonomy and entomology that are used to estimate time of death in forensic investigation
- C** Carry out techniques used to examine soil, pollen and diatom evidence in forensic investigation.

## Summary of unit

Learning aim	Key content areas	Recommended assessment approach
<b>A</b> Understand how concepts in taphonomy and entomology contribute to forensic investigation	<p><b>A1</b> Stages and processes of decomposition (taphonomy)</p> <p><b>A2</b> Factors affecting decomposition</p> <p><b>A3</b> Entomology, species identification and life cycles</p> <p><b>A4</b> Insect succession and effects on succession</p> <p><b>A5</b> Uses in forensic investigation</p>	<p>Research on stages and processes of taphonomy and entomology for presentation, with supporting observation form completed by assessor.</p> <p>A written report with a vocational aspect on the effects of the environment and burial on decomposition and entomology.</p>
<b>B</b> Carry out investigative techniques for taphonomy and entomology that are used to estimate time of death in forensic investigation	<p><b>B1</b> Scene recording and collection techniques</p> <p><b>B2</b> Laboratory entomological techniques</p> <p><b>B3</b> The post-mortem interval (PMI) and use of taphonomy and entomology in time of death (TOD) estimation</p>	<p>Scenario-led examination of taphonomy and entomological evidence. A written report with method, results and evaluation of analysis.</p> <p>Scenario-led questions on TOD estimation calculations, supported with worksheets.</p>
<b>C</b> Carry out techniques used to examine soil, pollen and diatom evidence in forensic investigation	<p><b>C1</b> Use of soil, sampling and analytical techniques</p> <p><b>C2</b> Use of pollen, sampling and analytical techniques</p> <p><b>C3</b> Use of diatoms, sampling and analytical techniques</p> <p><b>C4</b> Safety and authentication of sampling techniques for soil, pollen and diatoms</p>	<p>A report explaining the scientific techniques and the value of this type of evidence.</p> <p>Observation sheet for practical assessment.</p>

## Content

### Learning aim A: Understand how concepts in taphonomy and entomology contribute to forensic investigation

#### A1 Stages and processes of decomposition (taphonomy)

- Observations on initial decay (point of death), to include:
  - temperature decrease
  - pallor of skin (pallor mortis)
  - start of autolysis and putrefaction
  - clouding of vitreous humour and dilation of eye
  - skin discolouration.
- Identification of issues associated with putrefaction (bloating).
- Black putrefaction, including potential loss of fluid, hair, skin, nails and teeth.
- Butyric fermentation.
- Dry decay of skeletal remains.
- Other characteristics seen in decomposition, e.g. livor mortis, rigor mortis, algor mortis.

#### A2 Factors affecting decomposition

- Burial conditions, to include shallow and deep graves.
- Environmental effects, to include:
  - temperature
  - terrain, e.g. water logged, dry conditions, rivers, lakes
  - soil types
  - scavengers
  - insect activity
  - alternatives to skeletalisation, e.g. adipocere, mummification stages – forensic importance with retaining body and facial features.
- Effect of corpse condition, to include:
  - exposed and unexposed – location – external, e.g. woodlands, fields and internal, e.g. in houses, vehicles
  - wrapped/clothed corpse
  - trauma.

#### A3 Entomology, species identification and life cycles

- Insect and arthropods – species types.
- Life cycles – stages of: to include, egg, larvae (maggot), 1st instar, 2nd instar and 3rd instar, prepupal stage, pupa (puparium), adult (imago).
- Effect of stages of life cycle on behaviour and location of insects.
- Identification of larvae and adults, to include:
  - larval stage, e.g. size, length, colour
  - identification classification keys.
- Temperature effects on developmental stages in life cycle.

#### A4 Insect succession and effects on succession

- Stages of decomposition and species change, e.g. Calliphoridae, Sarcophagidae, Tineidae Dermestids.
- Effects on succession, e.g. predation, environmental changes, location, impact of buried and clothed bodies, drugs and alcohol on insect activity.

#### A5 Uses in forensic investigation

- Types of offences – serious crimes such as murders, abduction, sexual crime, sexual and drug-related deaths, wildlife crime, deliberate environmental destruction.
- Uses of environmental DNA (eDNA) in wildlife crime and species testing.

## **Learning aim B: Carry out investigative techniques for taphonomy and entomology that are used to estimate time of death in forensic investigation**

### **B1 Scene recording and collection techniques**

- Scene recording:
  - recording of samples, to include:
    - notes on location of eggs and larvae
    - labelling of time, date, place
    - visual and written records, e.g. photography, video, sketches, notes, data loggers
    - temperature recording, to include advantages and disadvantages of use of probes and infrared thermometers.
- Scene and mortuary collection:
  - use of personal protective equipment (PPE)
  - use of collection and transporting equipment, to include sieves, nets, forceps, brushes, aerated bottles, labels, preserving solvent, food for live samples
  - sampling all layers, base of grave and/or body in mortuary
  - sampling and separation of each insect stage and location
  - assessment of samples to be euthanised
  - storage and transport of live and dead samples.

### **B2 Laboratory entomological techniques**

- Use of classification keys in identifying adults collected from scene.
- Raising of larva to adulthood for identification purposes.
- Recording temperature and development times for use in estimating time of colonisation and predicting estimated time of death.

### **B3 The post-mortem interval (PMI) and use of taphonomy and entomology in time of death (TOD) estimation**

- Techniques from taphonomy for estimating TOD, to include:
  - assessment of the appearance of the corpse and Total Body Scores (TBS) – (appearance of head and neck, torso and limbs)
  - accumulated temperature effects – Accumulated Degree Days (ADD)
  - TOD estimation – TBS and ADD.
- Entomological techniques for estimating TOD, to include:
  - insect species behaviour and succession
  - temperature effects on species and life cycle stages.
- Effects on estimation of minimum PMI and time of death TOD, to include:
  - effects of the environment and temperature
  - effects of exposure/non-exposure to insect activity
  - size of corpse
  - effect of peri-mortem injury.
- Importance of research on taphonomy and entomology for TOD, e.g. body farms for research, pig grave experiments.

## **Learning aim C: Carry out techniques used to examine soil, pollen and diatom evidence in forensic investigation**

### **C1 Use of soil, sampling and analytical techniques**

- Geology and soil types, e.g. rocks, sediments, gems.
- Soil profile, e.g. types, colour, grain size, pH.
- Uses of soil, to include:
  - connection of soil to suspect/victim/scene
  - narrowing search of crime site from soil profile from items, e.g. suspect, clothes, footwear, spades, vehicles.

- Sampling techniques, to include:
  - site equipment, e.g. brushes, paper wraps, sieves, plastic sheeting
  - note of time and sampling location, e.g. upper layers, all layers in graves, season, suspect clothes, footwear and casts, vehicles
  - state of soil – wet and dry.
- Soil analytical techniques, to include:
  - cartography
  - photography
  - sieving
  - recording of colour, grain size, texture
  - knowledge of laboratory techniques, e.g. optical and polarised light microscopy, inductively coupled plasma mass spectroscopy (ICP-MS), x-ray diffraction with scanning electron microscopy (XRD-SEM), electron microprobe, isotopic analysis.

### **C2 Use of pollen, sampling and analytical techniques**

- Pollen structure and identification, e.g. size, shape, apertures, ornamentation.
- Dispersal mechanism, e.g. wind, animal and physical.
- Uses of pollen, to include:
  - connection of suspect to crime site/victim
  - estimate season of death/last time exposure of victim to environment
  - link to habitat type with pollen profile and concentration in soil
  - search aid for graves
  - identification of drugs, e.g. cannabis
  - consideration of seasonal species abundance, environment changes, preferential contact and persistence with different clothing fibre types.
- Sampling techniques, to include:
  - site equipment, e.g. taping, vacuuming with filters, brushes, nylon swabs
  - note of time sampling, e.g. season
  - note of sampling locations, e.g. indoors, outdoors, soil surface, layers in graves and beneath body, carpets, recovery of clothes, footwear, scrapings from hair, nails, nasal and vaginal swabs, vehicles.
- Pollen analytical techniques, to include:
  - preparation of slides, e.g. soil sample – acetolysis heavy liquid separation, swab washes and wipes, centrifugation
  - knowledge of laboratory techniques, e.g. optical microscopy, scanning electron microscope, transmission electron microscope, photography
  - counting and minimum number requirement
  - percentage comparison with environmental data and similarity abundance tests, e.g. cluster analysis
  - preferential species types, e.g. sticky pollen, substrate preference.

### **C3 Use of diatoms, sampling and analytical techniques**

- Diatoms types, e.g. centric, pennate.
- Structure and identification, e.g. bipartite siliceous cell walls (frustules), shape, symmetry, pore arrangement.
- Uses of diatoms, to include:
  - indicators of environmental changes
  - linkage to habitat type, e.g. freshwater, marine, soil
  - linkage of suspect to crime scene/victim, e.g. footwear, soil and sediment residues, clothes, evidence from vehicle
  - possible indication in body of cause of death, e.g. drowning
  - consideration of seasonal species abundance, environment changes, preferential contact and persistence with different clothing fibre types.

- Sampling techniques, to include:
  - site equipment – scrapings and litre water samples
  - note of time and location of sampling – season, water, e.g. near surface, sediment, moist areas, clothes, footwear; mortuary samples, e.g. lungs, kidneys and liver.
- Diatom analytical techniques, to include:
  - preparation of samples for slides, e.g. oxidation treatment of organic samples, preparation for microscopy
  - knowledge of laboratory techniques, e.g. optical microscopy with oil immersion, scanning electron microscope, transmission electron microscope, spectroscopy measurement, photography
  - counting and minimum number required
  - percentage comparisons with species data, comparison of different samples and similarity tests.

**C4 Safety and authentication of sampling techniques for soil, pollen and diatoms**

- PPE.
- Documentation and recording, e.g. labelling, photography, notes, measurements.
- Chain of continuity, anti-contamination controls, appropriate storage.

## Assessment criteria

Pass		Merit	Distinction
<b>Learning aim A: Understand how concepts in taphonomy and entomology contribute to forensic investigation</b>			<b>A.D1</b> Evaluate the use of taphonomy and entomology in forensic investigation.
<b>A.P1</b> Explain how entomology can affect the key processes of taphonomy in forensic investigation.	<b>A.M1</b> Assess the effect of different entomological processes on taphonomy in forensic investigation.		
<b>Learning aim B: Carry out investigative techniques for taphonomy and entomology that are used in order to estimate time of death in forensic investigation</b>			<b>B.D2</b> Evaluate the effectiveness of investigative techniques to estimate TOD in forensic investigation.
<b>B.P2</b> Explain how investigative techniques are used to collect and analyse taphonomy and entomological evidence in forensic investigation.	<b>B.M2</b> Analyse how investigative techniques are used in order to estimate TOD in forensic investigation.		
<b>B.P3</b> Perform calculations in order to estimate TOD.			
<b>Learning aim C: Carry out techniques used to examine soil, pollen and diatom evidence in forensic investigation</b>			<b>C.D3</b> Evaluate the techniques used to examine soil, pollen and diatom evidence and suggest improvements.
<b>C.P4</b> Examine soil, pollen and diatom evidence to draw conclusions.	<b>C.M3</b> Assess a range of examination techniques used in analysing soil, pollen and diatom evidence to draw conclusions.		
<b>C.P5</b> Explain how techniques are used to examine soil, pollen and diatom evidence.			

## Essential information for assignments

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

There is a maximum number of three 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)

## Further information for teachers and assessors

### Resource requirements

For performing practical work, learners must have access to entomological samples; microscopes; dead, fresh, unpreserved rats from biological resource companies for substituting human remains (and must be fully defrosted before use); cages; insect sampling and analytical equipment; maps or use of Google Earth™ for cartography; pollen grains; soil types; diatoms; slide databases; photographs; electron micrographs; pH meters; general laboratory equipment; calculators.

It is expected that where possible, appropriate investigative work will be carried out in this unit. Health and safety, and ethical considerations are paramount, and teachers must ensure that the necessary risk assessments are carried out and communicated to their learners. Refer to CLEAPSS and/or your centre's health and safety regulations if in doubt about any of the investigative work that has been suggested.

For this unit, teachers should select and use appropriate simulated forensic samples, where appropriate, for learners to investigate, that adhere to health and safety practices in place at the centre.

### Essential information for assessment decisions

#### Learning aim A

**For distinction standard**, learners will analyse and weigh up the advantages and disadvantages of using taphonomy and entomology in a forensic investigation. They will write a detailed piece of work using scenarios of different situations to support their findings and giving valid examples. Consideration must be given to the different investigations and situations a body may be discovered in and what evidence may be left for investigators to analyse.

**For merit standard**, learners will compare the changes in the stages of decomposition to processes caused by different entomological situations such as temperature changes caused by insect processes and how environmental temperature itself can affect insect activity and decomposition. Learners will assess other situations such as time of burial, submerging or covering of the body, location of the body, scavenging, effects of drugs and alcohol on insect activity etc., which can affect the opportunities of insect colonisation and the expected entomological processes.

**For pass standard**, learners will describe the main stages of decomposition and how these stages can be affected by insect colonisation. They will describe how insects enter the body and the type of insect species involved in the different stages of decomposition.

#### Learning aim B

**For distinction standard**, learners will discuss the benefits and limitations of the investigative techniques used to estimate time of death (TOD). They must include the effects of the environment and temperature, exposure or non-exposure to insect activity, size of corpse and peri-mortem injury on the estimation of the minimum post-mortem interval (PMI) and TOD and the importance of current research.

**For merit standard**, learners will write a detailed account of how investigative techniques are used to estimate TOD. They must analyse the importance and use of the appearance of the body, different environments, temperatures, insect stages and insect identification in the process of estimating TOD. Different forensic investigation situations can be used as examples to support learners' viewpoint.

**For pass standard**, learners will carry out and explain the main investigative techniques that are used to record, sample and analyse taphonomy and entomological evidence. Learners must explain in a report form how to record the appearance of the body and its environment and temperature, how to record the location of eggs and larvae, how to collect each insect stage and identify them in the laboratory. Learners will calculate simple estimates of TOD using temperature data and body

state, for example rigor mortis. Learners must be able to define Total Body Score (TBS), Accumulative Degree Days (ADDs), the minimum PMI and TOD.

### Learning aim C

**For distinction standard**, learners must consider the techniques used for sampling and laboratory examination, discussing the benefits and limitations of them in recovering and analysing the three evidence types of soil, pollen and diatoms. Learners must suggest improvements to how they used the techniques in the practical work and suggest improvements to the techniques themselves. Learners must suggest other techniques not used, for example electron microscopy, spectroscopy and mass spectroscopy, that they may consider better to gain results and explain why.

**For merit standard**, learners must consider the main examination techniques covering all three main evidence types, drawing conclusions from their assessment of the techniques. Learners must use their practical work results and findings in order to do this and give valid examples and detailed, complex conclusions. From the practical work, consideration can be given with regard to the matches in soil profile in relation to location, such as in graves and crime sites, and on items of clothing and artefacts from the victim and/or suspect. With regard to pollen and diatoms, consideration can be given to percentage comparisons with species data, seasonal abundance and consideration of preferential contact and persistence with different clothing fibre types. For pollen grains, this persistence with clothing can be more detailed, with the consideration of certain species types like 'sticky' pollen grains.

**For pass standard**, learners will investigate the main techniques concerned with the collection and analysis of soil, pollen and diatom evidence. Each evidence type must be covered and a report on them must be produced, with basic conclusions. In sampling for all evidence types, learners must consider anti-contamination, use of PPE, documentation and recording, chain of continuity, controls and storage etc. Learners must cover the main techniques of sampling, for example soil – brushing and sieving; pollen – taping, brushing and swabbing; diatoms – scrapings and sampling water. Learners must cover the main techniques of analysis, for example soil – recording of soil profile of pH, microscopy work with colour, grain size and texture; pollen – location, microscopy and slide preparation, identification, counting and minimum number; diatoms – location, microscopy and slide preparation, counting and minimum number.

Practical work can be supplemented with photographs (and if appropriate, electron micrographs can be used by learners to illustrate electron microscopy techniques) of the evidence and databases of pre-made slides for microscope work of pollen grains. If appropriate, mass spectrometer results can also be used by learners to illustrate isotopic techniques. Data of scene percentages of the evidence and other information can be used by the learner for comparison of their findings.

### Links to other units

This unit links to:

- Unit 1: Principles and Applications of Science I
- Unit 2: Practical Scientific Procedures and Techniques
- Unit 3: Science Investigation Skills
- Unit 4: Forensic Investigation Procedures in Practice
- Unit 8: Physiology of Human Body Systems
- Unit 13: Forensic Genetics
- Unit 14: Forensic Anthropology and Archaeology
- Unit 16: Microbiology and Microbiological Techniques.

### Employer involvement

This unit would benefit from employer involvement in the form of:

- specialist speakers such as police, scene of crime officers, laboratory and academic scientists, pest control and wildlife officers
- visits to environmental/pest control companies, wildlife organisations and institutions such as colleges or universities.

# Unit 10: Forensic Fire Investigation

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

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## Unit in brief

This unit covers the chemistry of combustion, the behaviour of fire, and the processes and personnel involved in the investigation of a fire scene.

## Unit introduction

Fire investigation is a specialist branch of forensic science. The analysis of a fire scene requires the investigator to determine the origin of the fire, the cause and how the fire developed. It is one of the more challenging areas of forensic science due to the destruction that occurs and the health and safety implications that are involved. The multi-disciplinary nature of the investigator's job requires them to understand the science behind the behaviour of fire and the chemistry of combustion and extinction.

In this unit, you will study how materials can ignite, burn and be extinguished, as well as the behaviour of fire itself. The unit explores the ways in which investigators can examine the remains of a fire and trace back, through the damage, to the point of origin, uncovering the evidence of what caused the incident and reconstructing the events. Fire investigators do not work alone. You will also examine the relationship of the fire investigator with different agencies and build an understanding of how they work together to extinguish a fire, treat casualties, make the site safe, and preserve and examine the evidence. The investigator's role doesn't end with the successful determination of the cause of a fire, as they can also be called to court as an expert witness. Learners will be expected to document their investigation and produce reports suitable for presentation in a court of law.

This unit will equip you to progress to higher-level courses. With more than 17 per cent of UK industry and business already depending on these advanced technologies, this unit opens up your awareness of a wide range of exciting career paths, especially work in the public service. Being able to describe your understanding and practical experience will help in interviews, as well as for degree courses in higher education.

## Learning aims

In this unit you will:

- A** Explore the chemistry of combustion and methods for extinction and heat transfer
- B** Explore the cause, phases and behaviour of fire
- C** Understand methods involved in processing a fire scene and the role played by agencies in fire prevention and investigation.

## Summary of unit

Learning aim	Key content areas	Recommended assessment approach
<p><b>A</b> Explore the chemistry of combustion and methods for extinction and heat transfer</p>	<p><b>A1</b> Chemistry of combustion  <b>A2</b> Methods used for extinguishing a fire  <b>A3</b> Heat transfer</p>	<p>A portfolio of method sheets and results, supported with an observation document completed by the assessor.</p> <p>A report containing conclusions of experimental work, relating it to the theory of combustion that is being investigated. The report should also include the justification of extinguishing methods.</p>
<p><b>B</b> Explore the cause, phases and behaviour of fire</p>	<p><b>B1</b> Causes of a fire  <b>B2</b> Phases of a fire  <b>B3</b> Fire behaviour</p>	<p>A visual presentation, including a description of how fires are caused and the phases of a fire.</p> <p>A report explaining the behaviours of fire and how behaviour is influenced by the cause and surroundings.</p>
<p><b>C</b> Understand methods involved in processing a fire scene and the role played by agencies in fire prevention and investigation</p>	<p><b>C1</b> Fire scene  <b>C2</b> Witness evidence  <b>C3</b> Documentation  <b>C4</b> Agencies involved in fire prevention and investigation</p>	<p>Learners should be given a mock scene or a vocational scenario. They should describe how they processed the scene in the way they did, justifying all of the methods used.</p> <p>A visual presentation, including a description of all the agencies involved, explaining and evaluating their role in the process of investigating a fire.</p>

## Content

### Learning aim A: Explore the chemistry of combustion and methods for extinction and heat transfer

#### A1 Chemistry of combustion

- Sources of ignition – primary and secondary.
- Combustion:
  - fire tetrahedron – heat, fuel, oxygen, chain reaction
  - glowing and smouldering combustion
  - colour of flames depending on the materials involved in the combustion
  - fuel and pyrolysis – solid, liquid, gas, conversion of fuel into the gaseous state by pyrolysis
  - heat of combustion – energy released as heat when a compound undergoes complete combustion with oxygen, under standard conditions
  - flash point and fire point
  - auto-ignition temperature, self-heating and self-ignition
  - fuel-controlled combustion
  - limits to flammability
  - products of combustion – heat, light and gaseous byproducts, water and carbon dioxide
  - toxic products, e.g. phenols, carbon monoxide, nitrogen oxides.

#### A2 Methods used for extinguishing a fire

- Smothering – fire blanket, chip-pan fire safety and boil over.
- Starving – cutting off the fuel supply.
- Cooling – applying water to reduce the temperature.
- Types of extinguisher – water, carbon dioxide, foam and dry chemical.

#### A3 Heat transfer

- Conduction – heat may be conducted from one body to another by direct contact of the two bodies (or by an intervening heat-conducting medium), different materials conduct better than others and this determines the rate at which heat is transferred.
- Convection – transfer of heat by the movement of air or liquid, fire spread by convection is mostly in an upward direction.
- Radiation – radiated heat will travel through space until it reaches an opaque object; radiated heat is one of the major sources of fire spread.

### Learning aim B: Explore the cause, phases and behaviour of fire

#### B1 Causes of a fire

- Natural, e.g. 'acts of God', such as lightning strikes
- Accidental, e.g. malfunction of an electrical appliance or an unattended candle.
- Deliberate – intentionally, arson, fire trail, fire-setting device, accelerants, multiple points of origin.
- Undetermined – if the fire investigator cannot determine the cause of the fire it is documented as undetermined.

#### B2 Phases of a fire

- Incipient phase.
- Growth phase.
- Free-burning phase (fully developed stage).
- Smouldering phase (decay stage).
- Heat release rate (HRR).

**B3 Fire behaviour**

- Flame propagation and the surroundings – depends upon the rate at which flammable pyrolysis products can be released from different materials:
- Rapid spread – chemically unstable solid materials, thermal insulators, low thermal materials conductivity, low-density materials, foamed plastics, thin sheets of material.
- Patterns – 'U' and 'V' pattern, truncated and inverted cones, hour glass, spalling of concrete and plaster.
- Point of origin.
- Plumes.
- Ventilation – limited and unlimited.
- Hot gas layer.
- Flame over.
- Flashover.
- Full room involvement/post flashover.
- Suppression.

**Learning aim C: Understand methods involved in processing a fire scene and the role played by agencies in fire prevention and investigation****C1 Fire scene**

- Role of the fire scene investigator – determining the cause of the fire, physical inspection, locating the seat of the fire, liaising with firefighters and witnesses.
- Scientific method approach.
- Safety – possible hazards: heated materials, structural collapse, damaged electricity and gas mains, debris, asbestos, dangerous combustion products and toxic substances; supplies of gas and electricity should be switched off before the investigation begins.
- Risk assessment – wear appropriate protective clothing such as hard hats, fire-resistant overalls, steel-capped boots, thick gloves and face masks.
- Preservation – strictly controlled by a cordon to preserve evidence and allow access to authorised personnel only.
- External examination:
  - entry point
  - signs of forced entry
  - indications as to the origin and cause of the fire
  - artifacts
  - all doors and windows should be examined to establish whether or not they were locked during the fire
  - search for items, such as tools, ladders or containers of flammable substances.
- Internal examination:
  - indications as to the origin and cause of the fire
  - layout of the scene detailing the location of items and any bodies
  - start with the area of least damage, backtrack to the seat of the fire, which will typically be found in a more damaged region.
- Recording findings (contemporaneous notes).
- Record weather conditions – temperature and wind conditions can affect a fire in terms of fire propagation and direction.
- Photographs of evidence and fire patterns.
- Drawing of scene – include the locations of objects.
- Excavation – remove debris to identify the possible origin, expose fire burn patterns.
- Collection of samples – liquid samples, solid samples, e.g. debris taken for analysis, comparison samples from unaffected areas.
- Packaging and preservation of samples – airtight containers, e.g. arson cans and nylon bags.
- Detection dogs or hydrocarbon sniffers to detect volatile substances.

**C2 Witness evidence**

- Eye-witnesses, e.g. occupiers, fire crew, neighbours.
- Interviews and transcripts of interviews.
- Transcripts of messages/phone calls to emergency services.
- Witness evidence – details of the premises prior to the fire, details of the fire, suspicious activity, fire spread, smoke colour, photographs or video recordings taken on mobile phones or cameras, details of the building contents, layout. Firefighters provide useful information on the possible origin of the fire, any unusual conditions and any disturbances made to the scene during firefighting efforts.

**C3 Documentation**

- Fire reports – incident recording system (IRS)
- Fire safety documents.
- Risk assessments.
- Diagrams.
- Floor plans.
- Room and contents.
- Contents reconstruction.
- Damage patterns.
- Presentation in court.

**C4 Agencies involved in fire prevention and investigation**

- Police, e.g. make the scene safe, identify casualties, gather information.
- Crime scene investigators (CSIs) – collect potential evidence from the scene.
- Specialist dog units, e.g. to indicate accelerants and the seat of fire.
- Forensic scientists, e.g. analyse materials collected from the scene.
- Pathologists.
- Gas advisor, e.g. for safety of others.
- Electricity advisor.
- Insurance loss adjuster.
- Health and Safety Executive (HSE).
- Solicitor.

## Assessment criteria

Pass		Merit	Distinction
<b>Learning aim A: Explore the chemistry of combustion and methods for extinction and heat transfer</b>			<b>A.D1</b> Evaluate the use of different methods of fire extinction in different scenarios and draw valid conclusions, using scientific terminology.
<b>A.P1</b> Carry out investigations into the chemistry of combustion, extinction and heat transfer, drawing conclusions and using scientific terminology.	<b>A.M1</b> Discuss the chemistry of combustion, extinction and methods of heat transfer, from practical observations and using scientific terminology.		
<b>Learning aim B: Explore the cause, phases and behaviour of fire</b>			<b>B.D2</b> Analyse how fire behaviour is influenced by its cause and the surroundings.
<b>B.P2</b> Describe how fires can be caused, their behaviours and the phases of a fire.	<b>B.M2</b> Discuss the causes and behaviours of different types of fire, and their phases and the impact of ventilation.		
<b>Learning aim C: Understand methods involved in processing a fire scene and the role played by other agencies in fire prevention and investigation</b>			<b>C.D3</b> Evaluate the methods used to process a fire scene and the roles of liaising agencies involved in order to preserve integrity of evidence.
<b>C.P3</b> Explain the methods involved in processing a fire scene.	<b>C.M3</b> Compare the methods involved in processing a fire scene.		
<b>C.P4</b> Describe the roles of agencies involved in a fire investigation.	<b>C.M4</b> Explain the importance of each agency involved in a fire investigation.		

## Essential information for assignments

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

There is a maximum number of three 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.M4, C.D3)

## Further information for teachers and assessors

### Resource requirements

For this unit, learners must have access to a well-equipped laboratory.

It is expected that where possible, appropriate investigative work will be carried out in this unit. Health and safety, and ethical considerations are paramount, and teachers must ensure that the necessary risk assessments are carried out and communicated to their learners. Refer to CLEAPSS and/or your centre's health and safety regulations if in doubt about any of the investigative work that has been suggested.

For this unit, teachers should select and use appropriate simulated forensic samples, where appropriate, for learners to investigate, that adhere to health and safety practices in place at the centre.

### Essential information for assessment decisions

#### Learning aim A

**For distinction standard**, learners will substantiate the use of the different methods for extinguishing a fire. The science of each method will be evaluated, with valid reasons for the choice of each technique used. This will be done from different scenarios involving a range of materials on fire. Learners will evaluate, using scientific terminology, the consequences of using the wrong extinguishing methods.

**For merit standard**, learners will discuss the fire tetrahedron and different sources of ignition, from practical observations giving examples of different sources of ignition. It is important that learners demonstrate an understanding of combustion in different circumstances and knowledge of toxic products is essential. They will discuss convection, conduction and radiation using scientific terminology and with examples of real-life applications in the transfer of heat.

**For pass standard**, learners will carry out investigations into the chemistry of combustion and extinction by performing experiments in the laboratory. Examples could include: heating cooking oil to demonstrate the conditions required to start combustion (this could be supplemented with a teacher demonstration of boil over); burning a solid hydrocarbon and drawing out the products of combustion with a pump over cobalt chloride paper in order to show the presence of water and – through limewater – the presence of carbon dioxide; a candle-burning experiment with different-sized beakers to simulate the necessity of oxygen in the fire tetrahedron and how to extinguish the flame by starving it of oxygen; a flame test to investigate the different flame colours or burning various coated paper, for example glossy, waxed and newspaper. Learners will also carry out investigations into heat transfer. They will draw conclusions for all investigations carried out, linking them to the chemistry of combustion, extinction and heat transfer.

#### Learning aim B

**For distinction standard**, learners will analyse how the different causes of fire can alter its behaviour, and how the presence of different materials contained within the scene can influence the rate of propagation. Learners will discuss examples of natural, accidental and deliberate causes of fire, giving examples. They will also give named examples of different solid, liquid and gas fuels, and how pyrolysis products influence behaviour.

**For merit standard**, learners will discuss the behaviour of fire using scientific terminology. They will discuss why patterns are created and why spalling occurs. Learners will also discuss why ventilation affects the behaviour of a fire and why the hot gas layer, flame over and flashover influence the behaviour of fire.

**For pass standard**, learners will explain the different causes of a fire, giving examples. They will also explain the behaviours and the phases of a fire. Learners will support their evidence with graphical data.

## Learning aim C

**For distinction standard,** learners will evaluate the different methods used for processing a fire scene and consider the consequences of not following procedures in terms of their importance in preserving the integrity of evidence for forensic analysis.

Learners will evaluate the role of each agency and the potential value of their contributions to the success of a fire investigation.

**For merit standard,** learners will compare the importance of the methods involved in processing a fire scene.

Learners will explain the role of each agency and the part they play in investigating fire. The role of the fire service is to fight fires and to protect people and property from fires. A fire investigation usually involves investigators from a number of other agencies who all have specific roles, including determination of the origin and cause of the fire, collection of evidence for a criminal investigation, assessment of the effectiveness of fire safety measures, and the estimation of loss. A team approach is essential and the legitimate interests of each agency need to be considered.

**For pass standard,** learners will explain the methods used to process a fire scene, stating why they are important. Learners should start to think of consequences of not carrying out methods precisely. This will also describe the different agencies involved in a fire investigation and outline their roles.

## Links to other units

This unit links to:

- Unit 1: Principles and Applications of Science I
- Unit 2: Practical Scientific Procedures and Techniques
- Unit 3: Science Investigation Skills
- Unit 4: Forensic Investigation Procedures in Practice
- Unit 6: Criminal Investigation Procedures in Practice
- Unit 11: Forensic Traffic Collision Investigation
- Unit 12: Forensic Photography.

## Employer involvement

Centres should develop links with local police constabulary, universities and analytical laboratories. Specialists from these areas are usually willing to speak to learners about their work. The fire service specialist Incident Investigation Team from the local fire and rescue service is also usually willing to contribute to the course. Companies that provide interagency fire investigation training to police and fire authorities may also be willing to speak to learners.



# Unit 11: Forensic Traffic Collision Investigation

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

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## Unit in brief

This unit covers the factors that cause road traffic collisions and injury, and how science is used in the road traffic collision investigation process.

## Unit introduction

Traffic collision investigation is a specialist branch of forensic science. This unit examines the role of the traffic collision investigator, focusing primarily on road collisions. An collision is an unexpected event that occurs without apparent or deliberate cause, but which has marked effects. The investigator will gather evidence from the site of the crash that will enable them to piece together the sequence of events that led to the collision. From this, they are able to say how the collision happened, what caused it and whether anyone is to blame. They may be called on to give evidence in court, to act as an expert witness or to advise on ways of improving safety. In this unit, you will investigate the major factors – human, environmental and vehicle – that relate to traffic collisions and develop an appreciation of the relationship between them. An understanding of the physics of forces and motion is essential for any collision investigator. You will study how the evidence left at a crash scene can be related to the momentum of the vehicles involved, and how this information can then be used in the reconstruction of events. You will also gain an appreciation of the extent and nature of the damage that can be done to vehicles, their occupants and pedestrians in a collision.

You will study and practise the techniques of identifying, recording and gathering evidence as part of the investigation process, and review how this information is then used in a collision reconstruction. The data gained from crash investigations is used to identify the factors that cause collisions. Knowledge of these factors allows cars and roads to be designed with safety in mind. This unit also covers the legislation associated with road safety.

This unit will equip you to progress to a range of applied science higher education courses. UK industry and business relies on scientific technologies and advances, and this unit opens up a wide range of exciting careers. Being able to describe your understanding and demonstrate, practically, the skills you have developed will help in interviews for advanced scientific or engineering apprenticeship roles, as well as for degree courses in higher education.

## Learning aims

In this unit you will:

- A** Investigate factors that cause road traffic collisions and injury
- B** Explore how science is used in the road traffic collision investigation process
- C** Use investigative techniques for road traffic collisions
- D** Understand legislation that applies to road traffic collision examination.

## Summary of unit

Learning aim	Key content areas	Recommended assessment approach
<b>A</b> Investigate factors that cause road traffic collisions and injury	<b>A1</b> Human factors <b>A2</b> Environmental factors <b>A3</b> Vehicle factors	Visual presentations, including a description of the factors that cause road traffic collisions.  A report explaining the relationship between the causal factors in road traffic collisions and the significance of each cause.
<b>B</b> Explore how science is used in the road traffic collision investigation process	<b>B1</b> Physics of movement and collision <b>B2</b> Driver's reaction <b>B3</b> Scientific road traffic investigation techniques	A portfolio of method sheets and the results of any speed, velocity or momentum investigations carried out, supported with an observation document completed by the assessor.  A report relating the scientific techniques used in road traffic collision investigation.
<b>C</b> Use investigative techniques for road traffic collisions	<b>C1</b> Investigative techniques <b>C2</b> Equipment and materials used at the scene <b>C3</b> Investigation aids <b>C4</b> Cost of traffic collisions	Learners should be given access to a mock or scenario-based road traffic collision. They should describe how and why they processed the scene in the way that they did, justifying all of the methods used. They should present the findings of any practical work carried out.
<b>D</b> Understand legislation that applies to road traffic collision examination	<b>D1</b> Road traffic acts <b>D2</b> Criminal justice system referral	A written report, including a description of the road traffic acts, explaining and evaluating them in relation to road traffic investigation.

## Content

### Learning aim A: Investigate factors that cause road traffic collisions and injury

#### A1 Human factors

- Behaviour or inexperience – driver error, lack of training/experience, speeding, injudicious action, stress, driver rage.
- Impairment or distraction – defective vision or other disability, drugs, alcohol, fatigue, mobile phone and satellite navigation use.
- Attitudes to drinking – zero tolerance, legal limit, drink driving.
- Education, e.g. annual campaigns, adverts at Christmas about drinking and driving.
- Passengers.

#### A2 Environmental factors

- Weather conditions – rain, ice, black ice, snow, sun, wind.
- Traffic control.
- Safety cameras.
- Signs impaired from view.
- Congestion.
- State of road, e.g. potholes, overhanging trees.
- Design of roadways, e.g. dual carriageway, motorway, three lanes.

#### A3 Vehicle factors

- Type and condition of vehicle.
- Braking system.
- Steering system.
- Tyres (types and defects) and tyre tread.
- Seat belts.
- Air bags.
- Crumple zones.
- Distribution of loads.
- Overloading.
- Maintenance – regular checks of oil, water, lights and general maintenance.
- Prior damage or modifications that are ill conceived and/or poorly executed.

### Learning aim B: Explore how science is used in the road traffic collision investigation process

#### B1 Physics of movement and collision

- Newton's laws of motion –  $v = u + at$ ,  $s = ut + \frac{1}{2}at^2$ ,  $v^2 = u^2 + 2as$
- Conservation of momentum – momentum =  $mv$ , force = time × change in momentum.
- Conservation of energy.
- Kinetic energy  $KE = \frac{1}{2}mv^2$
- Velocity  $v = \frac{d}{t}$
- Dynamic and static forces.
- Coefficient of friction between road surface and tyres,  $F = \mu R$  (where  $\mu$  is the coefficient of friction of the road surface).
- Effect of impact on vehicles, pedestrians and property.

## **B2 Driver's reaction**

- Factors affecting reaction time – environmental conditions, visibility, alcohol (blood alcohol concentration calculation, Widmark factor), drugs, alertness, hazards, cognitive psychology.

## **B3 Scientific road traffic investigation techniques**

- Documentation comparative methods.
- Naismith's rule – calculations based on a pedestrian's walking speed.
- Vehicle damage.
- Personal injuries.
- Road marks and their measurements.
- Vehicle or human rest position.

## **Learning aim C: Use investigative techniques for road traffic collisions**

### **C1 Investigative techniques**

- Skid test.
- Sled test.
- Projectile analysis.
- Interview – eyewitnesses, victims, emergency services present.
- Scene preservation and records – photography, sketch plans, measurement, casts of tyre prints.
- Data gathering – road surface data, coefficient of friction, skid marks (types and measurement), tachographs.
- Other evidence at scene – trace evidence, e.g. glass, hair, items of clothing.
- Health and safety – codes of practice, personal protective equipment (PPE), headwear and footwear, risk assessment.
- Collision reconstruction – manual and computer models.

### **C2 Equipment and materials used at the scene**

- Camera and tripod.
- Metrology instruments.
- Manometer and thermometer.
- Wax crayons and tracing paper.
- Scalpels for removing paint transfer and cutting samples of floor mats.
- Tweezers.
- Lifting tape.
- Crime sealing tapes.
- Engineering tools.
- Magnifier and microscope.
- Roadside tests – alcometers, intoximeters (gas chromatography).
- Weight and force measuring devices.
- Artificial light (torches).
- Casting tools and plaster.
- Exhibit vials, bags, packaging and labels.
- Scientific calculator.
- Measurements (tape and scales).
- Scene of crime kits.
- Dummies.

**C3 Investigation aids**

- Communication aids – mobile phone, laptop with internet connection.
- Scientific data manuals.
- Vehicle manufacturer data manuals.
- Claims forms.
- Forensic science reports.
- Forensic databases.

**C4 Cost of traffic collisions**

- Physical injury.
- Emergency services.
- Community.
- Family.
- Repair costs for vehicle.
- Road and property.
- Environmental.
- Insurance.

**Learning aim D: Understand legislation that applies to road traffic collision examination****D1 Road traffic acts**

- Construction and use – Road Safety Act 2006, Road Traffic Regulation Act 1984.
- Laws of contract.
- Criminal law.
- Documentation, e.g. ages to drive, carry passengers and loads.
- Local bylaws.
- Tachograph instruments.
- Laws on speeding.
- Legal limits for alcohol in body fluids.
- Drug laws – Police and Criminal Evidence (PACE) Act 1984.

**D2 Criminal justice system referral**

- Reports – statement of witness, including photographs, drawings, analysis of evidence.
- Expert witness.
- Giving evidence under oath.
- County magistrate and higher courts.

## Assessment criteria

Pass		Merit	Distinction
<b>Learning aim A: Investigate factors that cause road traffic collisions and injury</b>			<b>A.D1</b> Evaluate the significance of the different factors that cause of road traffic collisions and injury.
<b>A.P1</b> Explain the factors that cause road traffic collisions and injury.	<b>A.M1</b> Assess the interrelationship between the factors that cause road traffic collisions and injury.		
<b>Learning aim B: Explore how science is used in the road traffic collision investigation process</b>			<b>B.D2</b> Analyse the interrelationship between scientific factors in determining causes and the effect in road traffic collision investigations.
<b>B.P2</b> Explain why science is used in the investigation of the causes of road traffic collisions. <b>B.P3</b> Calculate velocity and use the coefficient of friction to determine the speed of vehicles before a collision from collision scenarios.	<b>B.M2</b> Discuss the scientific factors associated with the investigation of road traffic collisions.		
<b>Learning aim C: Use investigative techniques for road traffic collisions</b>			<b>C.D3</b> Evaluate the procedures and equipment used for evidence collection and analysis from a simulated collision investigation.
<b>C.P4</b> Follow procedures to carry out an investigation of a road traffic collision. <b>C.P5</b> Analyse evidence from a simulated collision investigation.	<b>C.M3</b> Justify the procedures and the choice of equipment used to investigate a collision.		
<b>Learning aim D: Understand legislation that applies to road traffic collision examination</b>			<b>D.D4</b> Evaluate the purpose and effectiveness of the legislation that applies to road traffic collisions and the criminal justice system, making suggestions for improvements.
<b>D.P6</b> Explain the purpose of legislation that applies to road traffic collisions.	<b>D.M4</b> Discuss the purpose and effectiveness of the legislation that applies to road traffic collisions.		

## Essential information for assignments

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

There is a maximum number of two 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, learners must have access to a well-equipped laboratory.

It is expected that where possible, appropriate investigative work will be carried out in this unit. Health and safety, and ethical considerations are paramount, and teachers must ensure that the necessary risk assessments are carried out and communicated to their learners. Refer to CLEAPSS and/or your centre's health and safety regulations if in doubt about any of the investigative work that has been suggested.

For this unit, teachers should select and use appropriate simulated forensic samples, where appropriate, for learners to investigate, that adhere to health and safety practices in place at the centre.

### Essential information for assessment decisions

#### Learning aim A

**For distinction standard**, learners will evaluate the relationships between the causal factors in road traffic collisions, and the relative importance of each factor in causing road collisions and injury. They will use their knowledge to comment on how these factors could be avoided (if at all) or used to improve road safety.

**For merit standard**, learners will assess the interrelationship between the factors that cause road traffic collisions and injury. They will explain why these factors (whether on their own or combined) can cause road collisions.

**For pass standard**, learners will explain the factors that can cause road traffic collisions and injury covering all of the unit content. They will describe how each factor could potentially cause a road collision. For example, speeding means that the driver would be going too fast for the conditions in that given area and would be unable to stop in time to avoid a collision with any obstacles, for example pedestrian, vehicle, wall and so on.

#### Learning aim B

**For distinction standard**, learners will analyse the relationships between scientific factors and how this information can be used in road traffic collision investigations in order to work through cause and effect. For example, the speed of a vehicle at impact can be calculated using known variables and scientific principles.

**For merit standard**, learners will discuss, using scientific detail, the scientific factors associated with road traffic collisions. For example, they can look at the coefficient of friction of a surface, the environmental conditions and the reaction time of the driver.

**For pass standard**, learners will explain why science is used in the investigation of road traffic collisions. This could be in the form of a portfolio outlining the more common techniques used by traffic collision investigators. Learners will understand the concepts of appropriate scientific principles and their use in road traffic collision investigations. Learners will also be given the opportunity to carry out practical investigations into the scientific techniques listed, for example friction to simulate surface and tyres, speed, kinetic energy and velocity. Learners will be able to use equations to calculate motion, velocity and coefficient of friction from given traffic collision scenarios.

#### Learning aim C

**For distinction standard**, learners will draw appropriate conclusions from practical investigations as to the cause of the road traffic collision. They will evaluate their findings and assess the reliability of their evidence. Learners will evaluate the techniques used to investigate the scene, explaining the advantages of their chosen techniques. They will also justify the equipment and materials used for evidence collection.

**For merit standard,** learners will justify the methods used to collect evidence at the scene, how this evidence is analysed and how it is used to help determine the cause of a collision, for example why should broken glass found at a collision scene be packaged in solid plastic containers? Learners will also explain why all equipment listed in the unit content is necessary in road traffic collision investigation.

**For pass standard,** learners will conduct a simulated collision investigation ensuring that information is gathered in a systematic way, paying attention to all relevant details. They will produce a detailed collision investigation report, including notes and descriptions of the site, the state of the road, the vehicle(s), photographic documentation, measurements, sketches and plans. Sketches and plans will include a key with directional information, measurements and scales. The positions of the vehicle(s) – including point of impact and rest – the surroundings, debris, victims, trace evidence positions and damage will all be recorded. Techniques can also include photographic evidence of tyre marks, swabbing of biological evidence and subsequent appropriate packaging. If the teacher is dealing with a mainly laboratory-based investigation, some of these details could be worked on using data and photographic images or a skeleton layout scene or computer/video reconstruction. However, learners will carry out suitable investigations, for example analysing trace evidence such as paint, or larger items such as a car headlamp or tyre, or measurement of blood alcohol with gas chromatography. At collision scenes, many other agencies – such as the emergency services – will be in attendance, so teamwork and good communication skills are paramount. Learners will exhibit such skills at the scene. They must also then use the evidence collected to analyse what has happened and draw conclusions, such as cause and effect, blame and next actions, for example to prosecute one or all parties, or not.

### Learning aim D

**For distinction standard,** learners will evaluate the purpose of legislation and assess the effectiveness of the legislation that applies to road traffic collisions. Learners will be able to classify collisions and the vehicles involved through the applicable legislation, for example a collision caused by overloading. Learners will evaluate the role of the applicable laws and their contribution to the prevention of road traffic collisions.

**For merit standard,** learners will discuss the purpose and effectiveness of the legislation that applies to road traffic collisions. They will discuss why these laws have been formulated and how effective they are. They could use published data to help with explaining effectiveness.

**For pass standard,** learners will explain the reason for legislation that applies to road traffic collisions. They will explain areas that are covered by legislation and how this helps investigations of road traffic collisions. They should also include why legislation is necessary.

### Links to other units

This unit links to:

- Unit 1: Principles and Applications of Science I
- Unit 2: Practical Scientific Procedures and Techniques
- Unit 3: Science Investigation Skills
- Unit 4: Forensic Investigation Procedures in Practice
- Unit 6: Criminal Investigation Procedures in Practice
- Unit 11: Forensic Traffic Collision Investigation
- Unit 12: Forensic Photography.

### Employer involvement

Centres should develop links with local police authorities and universities. Road traffic collision investigators and other specialists are usually willing to speak to learners about their work.



# Unit 12: Forensic Photography

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

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## Unit in brief

Learners will study photographic techniques, consider processes and develop the skills needed to produce photographs of a simulated crime scene, comparable with those used in the Criminal Justice System (CJS).

## Unit introduction

Photographs provide a permanent visual record of scenes and events. Photographs taken for forensic purposes must provide accurate information about a crime scene at the time the incident occurred and are a permanent record of evidence. This is important as pieces of evidence have to be removed and scenes change and deteriorate with time. The role of the forensic photographer is vital in producing a visual record of evidence that can be verified as accurate and could be used in a court of law.

In this unit, you will learn about cameras and the photographic equipment that is needed to take high-quality digital photographs. You will develop an understanding of photographic techniques and learn the skills needed to produce photographs of crime scenes and individual pieces of evidence. You will learn how photographs can be enhanced using computer programs in order to give a record of events that can be presented in court.

The knowledge and skills that you develop in this unit will give you some insight into the photographic work carried out by crime scene investigators (CSI). This will be useful when applying for higher education courses such as a degree in forensic science, which could lead to a job with a police force as a trainee CSI or a job with a private forensic organisation.

## Learning aims

In this unit you will:

- A** Develop a plan to obtain photographic evidence from a simulated crime scene
- B** Use photographic equipment and techniques to produce a visual record of evidence from a simulated crime scene
- C** Review the suitability of the visual record produced in accordance with use of photographic evidence presented in a court of law.

## Summary of unit

Learning aim	Key content areas	Recommended assessment approach
<p><b>A</b> Develop a plan to obtain photographic evidence from a simulated crime scene</p>	<p><b>A1</b> Photographic equipment  <b>A2</b> Photographic theory and techniques  <b>A3</b> Structure of a plan</p>	<p>A plan to show how photographic equipment and techniques can be used to produce digital photographs that provide a visual record of a crime scene.</p> <p>Observation of the use of photographic equipment and processes to take photographs to be used to produce a visual record of evidence from a simulated crime scene.</p>
<p><b>B</b> Use photographic equipment and techniques to produce a visual record of evidence from a simulated crime scene</p>	<p><b>B1</b> Photographing a simulated crime scene  <b>B2</b> Documentation of a visual record of evidence from a simulated crime scene</p>	
<p><b>C</b> Review the suitability of the visual record produced in accordance with use of photographic evidence presented in a court of law</p>	<p><b>C1</b> Use of photographic evidence in a court of law  <b>C2</b> Value of a visual record of evidence</p>	<p>A report to demonstrate an understanding of the use of photographic evidence in a court of law, and an evaluation of the extent to which the portfolio produced fulfils the requirements of the courts to which this evidence could be presented.</p>

## Content

### Learning aim A: Develop a plan to obtain photographic evidence from a simulated crime scene

#### A1 Photographic equipment

- Camera formats, including digital and phone.
- Lens types, including standard, wide angle, telephoto, macro, and fish-eye.
- Accessories, including tripod, remote release, cable release.
- Light sources, including white light (light-emitting diode (LED), flash, fluorescent), ultraviolet (UV) light, laser, infrared, Crime-lite®.
- Colour filters.
- Light meters.

#### A2 Photographic theory and techniques

- Theory of light, incident, specular reflection, diffuse reflection, ambient reflection, refraction, intensity variation with distance from the source of light.
- Theory of standard convex lens, focal length, variation of distance image with object distance, magnification, ray diagrams.
- Exposure control, including ISO (level of sensitivity to available light), aperture, shutter speed.
- Colour images, white balance.
- Focusing, depth of field, distortion.
- Image processing, pixels, resizing, aspect ratio, resolution
- Image storage file formats, including raw and JPEG.
- Use of digital imaging software, such as Photoshop®, to enhance images, to include lightening, darkening, cropping, white balance adjustment. Log of changes made.
- Use of bounced or balanced flash.

#### A3 Structure of a plan

- Crime scene security, restricted access, safety.
- Personal protective equipment (PPE), coveralls, masks, gloves, overshoes.
- Conditions – inside or outside, day or night, rain, snow, fog, sunshine.
- Equipment to take to scene – cameras, lighting equipment, markers, forensic scale ruler measuring tape, compass.
- Order of photographs.
- Range of photographs.
- Log of photographs.
- Chain of continuity.

### Learning aim B: Use photographic equipment and techniques to produce a visual record of evidence from a simulated crime scene

#### B1 Photographing a simulated crime scene

- Use of personal protective clothing.
- Approach to crime scene, identifying relevant evidence, using markers, avoiding contamination or destruction of evidence.
- Taking measurements, making notes and diagrams.
- Selecting appropriate equipment.
- Use of cameras, lighting, light meters, tripods and techniques appropriate to the crime scene.
- Techniques for a specific simulated crime scene, inside or outside.
- Photographing site, including overview, mid-range and close-up photographs using appropriate perspectives and camera angles.

- Photographing pieces of evidence, using a scale or reference object.
- Using scales and colour charts in image capture.

### **B2 Documentation of a visual record of evidence from a simulated crime scene**

- Diagrams and notes to explain site orientation.
- Diagrams and notes to explain positions of objects photographed.
- Photo log giving date, time, location and explaining content for each photograph.
- Image selection.
- Security, storage of authenticated master image, secure server, CD.
- Enhancement of images with log of changes made.
- Log of storage of all original images.
- Log of chain of continuity.
- Printing of selected images.
- Comparison of original digital images with printed versions, to include colour changes.
- Reason for choice and order of images.

### **Learning aim C: Review the suitability of the visual record produced in accordance with use of photographic evidence presented in a court of law**

#### **C1 Use of photographic evidence in a court of law**

(Statutes and regulations current at the time of teaching should be used.)

- Purpose of photographic evidence.
- Chain of continuity, evidence preservation.
- Relevance of scales, markers, and colour charts measurements.
- Exposure of hidden (latent) marks, fingerprints.
- Enhancement of evidence for photographs of shoe prints, blood stains, tyre marks.
- Quality of digital forensics, police and private companies, Forensic Science Regulator (FSR), Home Office Digital Imaging Procedure, Scientific Working Group on Imaging Technologies (SWGIT).
- Admissible evidence, Criminal Evidence Act 1984, Crown Prosecution Service (CPS), legal guidance for exhibits, Criminal Justice Act 2003, coroners' courts, civil proceedings.

#### **C2 Value of a visual record of evidence**

- Technical knowledge used to take photographs.
- Success of the evidence-gathering process.
- Clarity of the original visual record.
- Photographs used to show site features.
- Photographs used to show pieces of evidence.
- Enhancements to photographs used in the portfolio.
- Documentation used to verify chain of continuity.

## Assessment criteria

Pass	Merit	Distinction
<b>Learning aim A: Develop a plan to obtain photographic evidence from a simulated crime scene</b>		
<b>A.P1</b> Produce a plan to obtain photographic evidence from a simulated crime scene.  <b>A.P2</b> Explain how equipment and techniques could be used to produce photographic evidence of a simulated crime scene.	<b>A.M1</b> Produce a plan with logically ordered steps to obtain photographic evidence from a simulated crime scene, indicating the use of equipment and techniques required.	
<b>Learning aim B: Use photographic equipment and techniques to produce a visual record of evidence from a simulated crime scene</b>		<b>AB.D1</b> Justify the use of equipment and techniques to produce high-quality, well-documented and ordered photographic images for a visual record of a simulated crime scene.
<b>B.P3</b> Demonstrate the use of equipment to produce photographic images of a simulated crime scene.  <b>B.P4</b> Demonstrate the use of techniques to produce photographic images that provide visual information about a simulated crime scene.	<b>B.M2</b> Demonstrate effective use of equipment and techniques to produce a range of photographic images for a visual record of a simulated crime scene.	
<b>Learning aim C: Review the suitability of the visual record produced in accordance with use of photographic evidence presented in a court of law</b>		<b>C.D2</b> Assess the limitations of the visual record as providing evidence of the crime scene in a court of law.
<b>C.P5</b> Explain the requirements of presenting visual evidence in a court of law.  <b>C.P6</b> Explain how the visual record of the simulated crime scene meets the legal requirements for use as evidence in a court of law.	<b>C.M3</b> Discuss how the visual record meets the legal requirement so that it can be used as evidence in a court of law.	

## Essential information for assignments

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

There is a maximum number of two 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, learners must have access to cameras (could be on phones), light meters (an app can be downloaded), colour filters, tripod (stand on which to rest cameras), release cable, sources of light, including a Crime-lite, convex lenses, forensic scales, markers and colour charts, measuring tapes, rulers, compasses, digital software for image enhancement.

It is expected that where possible, appropriate investigative work will be carried out in this unit. Health and safety, and ethical considerations are paramount, and teachers must ensure that the necessary risk assessments are carried out and communicated to their learners. Refer to CLEAPSS and/or your centre's health and safety regulations if in doubt about any of the investigative work that has been suggested.

### Essential information for assessment decisions

#### Learning aims A and B

**For distinction standard**, learners will produce a detailed plan that is logically ordered and used to make a visual record of a crime scene. They will use photographic equipment and light sources effectively, demonstrating an in-depth understanding of the theory and techniques used to enable high-quality visual images to be produced, giving a rationale for selected techniques. Learners will produce a portfolio that contains all the essential information relating to the crime scene, including a logical ordering of photographs, diagrams of the crime scene and an explanation of the range and choice of images. Learners will take into account reasons for enhancements, chain of continuity and consider the effectiveness of the original plan.

**For merit standard**, learners will produce a detailed plan that is in a logical order and used to make a visual record of a crime scene. They will use photographic equipment with skill and apply their understanding of some theories and techniques to produce a range of photographs of a simulated crime scene and the evidence it contains. Learners will produce a comprehensive portfolio of visual images of a crime scene, giving some detail of the crime scene and giving reasons for their choice of photographs in relation to their original plan.

**For pass standard**, learners will produce an outline plan to be used to make a visual record of a crime scene. They will use photographic equipment to produce a series of photographs of the crime scene and pieces of evidence, and demonstrate an understanding of the techniques used to improve the quality of photographs. Learners will produce a portfolio of visual images, relating them to the crime scene and describing how the production of the photographs follows their original plan.

#### Learning aim C

**For distinction standard**, learners will demonstrate a depth of knowledge and understanding for the admission of different types of photographic evidence in civil, criminal and coroners' courts. Learners will use their knowledge of photographic techniques and processes to evaluate the merits and faults of the photographs they have produced and judge the extent to which the whole portfolio could be used to provide credible evidence for a court of law.

**For merit standard**, learners will discuss how the legal framework in place allows different types of photographic evidence to be used in court. Learners will discuss the quality of the photographs they have produced, giving the changes that need to be made to the photographic techniques used to enable the whole portfolio to be used to provide evidence in a court of law.

**For pass standard**, learners will explain the requirements of the legal framework used to allow different types of photographic evidence to be used in court. Learners will describe the good and bad points of the photographs produced and explain how they could be improved to produce a portfolio of evidence that would be suitable for use in a court of law.

## Links to other units

This unit links to:

- Unit 4: Forensic Investigation Procedures in Practice
- Unit 6: Criminal Investigation Procedures in Practice
- Unit 9: Environmental Forensics
- Unit 10: Forensic Fire Investigation
- Unit 11: Forensic Traffic Collision Investigation
- Unit 14: Forensic Anthropology and Archaeology.

## Employer involvement

This unit would benefit from employer involvement in the form of visiting speakers, including a police force scenes of crime officer with responsibility for forensic photography, a local photographer, a lecturer in photography or a representative from a legal practice.

# Unit 13: Forensic Genetics

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

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## Unit in brief

Learners develop understanding of heredity, genetic engineering and their application to forensic science.

## Unit introduction

DNA has been an important tool in forensic science for many years. Forensic geneticists analyse DNA primarily in medical or crime laboratories, where they use the genetic samples to help identify crime victims and perpetrators.

A forensic geneticist analyses blood, fluids and tissue samples to extract DNA for identification or evidence. This unit will help you develop the skills needed to analyse and interpret DNA evidence as part of a criminal investigation. In this unit, you will learn about and carry out a variety of techniques to investigate DNA. You will produce a portfolio of practical outcomes. The use of data from the DNA database, and the issues surrounding this, will also be examined.

This unit will enable you to develop knowledge and skills that will be useful in applying for courses in higher education such as forensic science. A forensic science degree could lead to a career as a forensic scientist or forensic laboratory assistant, providing impartial scientific evidence for courts. It could also lead to a master's degree in forensic genetics, forensic anthropology, or identification of human remains or related fields.

## Learning aims

In this unit you will:

- A** Understand the mechanism of DNA replication and its regulation
- B** Explore techniques used to extract and amplify DNA from biological material for further forensic analysis
- C** Explore methods used in forensic analysis of DNA
- D** Understand how the results of DNA analysis are used in forensic investigation.

## Summary of unit

Learning aim	Key content areas	Recommended assessment approach
<b>A</b> Understand the mechanism of DNA replication and its regulation	<b>A1</b> The molecular biology of DNA <b>A2</b> Semi-conservative replication <b>A3</b> Regulation of DNA replication	A portfolio of evidence, to include: <ul style="list-style-type: none"> <li>• a PowerPoint® presentation explaining DNA structure and function, how DNA replicates and the factors affecting replication</li> <li>• a report discussing causes and impact of variation in the replication process, modes of regulation of DNA replication and the impact of regulation on the genotype and phenotype.</li> </ul>
<b>B</b> Explore techniques used to extract and amplify DNA from biological material for further forensic analysis	<b>B1</b> Basic practical techniques in extraction of DNA <b>B2</b> Special practical techniques for extraction of DNA <b>B3</b> Polymerase chain reaction (PCR)	A portfolio of evidence, to include: <ul style="list-style-type: none"> <li>• a report on essential components of a DNA extraction with an observation record to validate the practical work carried out on the extraction of DNA</li> <li>• a comparative assessment of the different techniques used to isolate and extract DNA from a variety of sources</li> <li>• annotated diagrams of stages of the polymerase chain reaction, how and where the stages occur and analysis of the impact of possible errors.</li> </ul>
<b>C</b> Explore methods used in forensic analysis of DNA	<b>C1</b> Principles of restriction enzyme analysis <b>C2</b> Principles and application of gel electrophoresis in forensic science	A portfolio of evidence, to include: <ul style="list-style-type: none"> <li>• observation records</li> <li>• a practical report assessing the use of restriction enzyme analysis and gel electrophoresis in the identification of a DNA sample (crime scene context). A report is then presented in the form of expert testimony, evaluating the outcomes of practical work.</li> </ul>
<b>D</b> Understand how the results of DNA analysis are used in forensic investigation	<b>D1</b> Use and validity of DNA data	A portfolio of evidence, to include: <ul style="list-style-type: none"> <li>• an information booklet on the use of DNA data in the National DNA Database</li> <li>• an analysis of the importance, validity and implications for society of storing DNA data in a DNA database and evaluating the use of DNA data.</li> </ul>

## Content

### Learning aim A: Understand the mechanism of DNA replication and its regulation

#### A1 The molecular biology of DNA

- DNA structure, to include structure of nucleotides, ribose sugar, sugar phosphate backbone, complementary base pairing, hydrogen bonding, 3' and 5' positions.
- Uniqueness of DNA sequence in terms of nucleotide structure.
- Reasons for variation, including introduction to polymorphisms, mutations, gene, allele, locus.
- The way in which the structure of DNA provides a mechanism for heredity.

#### A2 Semi-conservative replication

- Mechanism by which DNA unwinds the double helix in preparation for replication.
- Okazaki fragments, deoxynucleoside triphosphates, leading strand, lagging strand, replication fork, antiparallel strands, single-strand binding proteins.
- Functions of the DNA polymerase, helicase and ligase in replication.
- Explain the semi-conservative nature of DNA replication.

#### A3 Regulation of DNA replication

- Stages of the cell cycle, to include cellular activities at each stage and the checkpoints involved in progressing from one stage to the next.
- Importance of regulation of DNA replication.
- Impact of errors in DNA replication, to include insertion/deletion of a base, point mutation, translocation.
- The position of DNA replication in the cycle and activities in the cycle that can affect DNA replication.
- The origin of variation in the DNA sequence (sexual reproduction/meiosis, mutation, copying errors, genetic drift) and its contribution of this to the uniqueness of an individual's DNA.

### Learning aim B: Explore techniques used to extract and amplify DNA from biological material for further forensic analysis

#### B1 Basic practical techniques in extraction of DNA

- Method of recovery of nuclear material from a variety of biological sources – blood, semen, saliva, urine, hair (without root and shaft), teeth, bone and tissue.
- Essential components of a DNA extraction procedure (maximise DNA recovery, remove inhibitors, remove or inhibit nucleases, maximise the quality of DNA).
- Methods of extraction and the reagents involved (including removal of proteins by extracting aqueous solutions of nucleic acids).
- Pros and cons of extraction methods, e.g. reference to quantification of DNA.

#### B2 Special practical techniques for extraction of DNA

- Procedures used in concentrating/precipitating DNA, e.g. alcohol precipitation.
- Non-organic extraction procedures – inorganic chemicals, detergents, ethylenediaminetetraacetic acid (EDTA), acetic acid, salt (salting out, spooling).
- Solid phase: DNA immobilised on a solid support, beads or columns.
- Pros and cons of extraction methods, e.g. reference to quantification of DNA.
- Importance of choosing the right technique – specimen type and its volume.
- Procedural factors – effect of size or volume of each sample; amount of DNA or RNA required; equipment and tube sizes required; processing speed; required yield of DNA/RNA, purity of DNA/RNA; ease of operation.

**B3 Polymerase chain reaction (PCR)**

- Importance of:
  - primers
  - DNA polymerase
  - nucleotides
  - temperature controls.
- Impact of replication errors.
- Purpose of using PCR to amplify DNA.

**Learning aim C: Explore methods used in forensic analysis of DNA****C1 Principles of restriction enzyme analysis**

- Types and origin of restriction enzyme, e.g. haemophilus aegypticus, HaeIII, EcoRI, BamHI, HindIII.
- The mechanism of DNA restriction enzyme action.
- Nomenclature, recognition sites, sticky ends and blunt ends.
- Cutting and recombining with restriction enzymes.
- Procedure for use of a restriction digestion map to identify a sample DNA from a crime scene.

**C2 Principles and application of gel electrophoresis in forensic science**

- Basic principles – charge/size migration.
- Types of gel, agarose, polyacrylamide and starch.
- Gel conditions, use of buffers, optimisation of migration.
- Visualisation, including staining, fluorescence and sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE) autoradiography.
- Polymorphism analysis – compare and contrast different types of polymorphisms, e.g.:
  - variable number tandem repeats (VNTRs)
  - restriction fragment length polymorphism (RFLP)
  - short tandem repeats (STRs)
  - single-nucleotide polymorphism (SNP).
- Types of DNA and application to profiling, e.g.:
  - nuclear DNA
  - mitochondrial DNA
  - ySTR chromosomal DNA.
- Environmental DNA (eDNA) and use in wildlife crime investigation and species testing.
- Interpretation of outcomes, including calibration, DNA ladders, matching, electropherogram interpretation.
- Positions of the  $\lambda$  DNA bands on a gel in relation to known  $\lambda$  DNA restriction map.
- The role of the expert witness (e.g. forensic geneticist), including reference to expert report writing and skills required for expert testimony.
- Communicating outcomes, including statistical considerations – probability and chance, population data, distribution of alleles, likelihood ratio.
- Other methods in DNA analysis, e.g. capillary electrophoresis technology and robotics (use in next generation sequencing).

**Learning aim D: Understand how the results of DNA analysis are used in forensic investigation****D1 Use and validity of DNA data**

- What is a DNA database and how did it originate? – Colin Pitchfork case, National DNA Database (NDNAD), Combined DNA Index System (CODIS).
- Loci analysis England, Wales and Northern Ireland looks at 17 areas (known as DNA 17) as part of the NGM (Next Generation Multiplex), whereas Scotland looks at 24 areas (known as DNA 24).
- Database subjects – source of data, Criminal Justice and Police Act 2001, Criminal Justice Act 2003, Protection of Freedoms Act 2012. Restrictions and issues regarding use of DNA data.
- Legal and privacy concerns – paternity, Human Tissue Act 2004, Police and Criminal Evidence (PACE) Act 1984, Terrorism Act 2006.
- Factors affecting accuracy of outcomes, e.g. contamination.

## Assessment criteria

Pass		Merit	Distinction
<b>Learning aim A: Understand the mechanism of DNA replication and its regulation</b>			<b>A.D1</b> Evaluate the impact of variation in the DNA sequence and how this contributes to uniqueness of DNA.
<b>A.P1</b> Explain the mechanism of DNA replication.	<b>A.M1</b> Discuss the cause and impact of variation in DNA replication and the regulatory roles of enzymes in managing the variation.		
<b>A.P2</b> Explain the importance of regulation on DNA replication, with reference to the cause and impact of variation.			
<b>Learning aim B: Explore techniques used to extract and amplify DNA from biological material for further forensic analysis</b>			<b>B.D2</b> Evaluate the use of different techniques to extract and amplify DNA from a variety of biological material.
<b>B.P3</b> Competently extract DNA from biological material.	<b>B.M2</b> Assess factors that affect the choice of technique to extract DNA from biological material.		
<b>B.P4</b> Use outcomes from practical work carried out to explain how PCR is used in the amplification of DNA.	<b>B.M3</b> Discuss the impact of errors in the regulation of DNA amplification by PCR.		
<b>Learning aim C: Explore methods used in forensic analysis of DNA</b>			<b>C.D3</b> Evaluate the methods used to analyse DNA in the identification of a biological sample.
<b>C.P5</b> Carry out DNA analysis in the identification of a biological sample.	<b>C.M4</b> Discuss the outcomes of DNA analysis in identification of a biological sample using practical work.		
<b>Learning aim D: Understand how the results of DNA analysis are used in forensic investigation</b>			<b>D.D4</b> Evaluate the use of DNA data in a forensic investigation.
<b>D.P6</b> Describe how DNA data is used in a forensic investigation.	<b>D.M5</b> Explain the use of DNA data in a forensic investigation.		

## Essential information for assignments

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

There is a maximum number of four 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.M3, B.D2)

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

Learning aim D: (D.P6, D.M5, D.D4)

## Further information for teachers and assessors

### Resource requirements

For this unit, learners must have access to:

- a well-equipped laboratory
- commercially prepared materials/kits that can be purchased to facilitate extracting DNA, restriction enzyme analysis, gel electrophoresis and polymerase chain reactions.

It is expected that where possible, appropriate investigative work will be carried out in this unit. Health and safety, and ethical considerations are paramount, and teachers must ensure that the necessary risk assessments are carried out and communicated to their learners. Refer to CLEAPSS and/or your centre's health and safety regulations if in doubt about any of the investigative work that has been suggested.

For this unit, teachers should select and use appropriate simulated forensic samples, where appropriate, for learners to investigate, that adhere to health and safety practices in place at the centre.

### Essential information for assessment decisions

#### Learning aim A

**For distinction standard**, learners will demonstrate a thorough understanding of DNA structure and refer competently to the components of DNA in their explanations. They will use their knowledge of the cell cycle and replication mechanisms to explain the origin of natural variations in the DNA sequence. They must discuss all causes of variation and evaluate the effect on measurable differences in the DNA. The evidence must include strengths and weaknesses, and give a supported judgement of the impact of DNA sequencing and how this contributes to the uniqueness of the DNA of an individual.

**For merit standard**, learners must clearly demonstrate their understanding of DNA structure to explain what is occurring at each stage in semi-conservative replication. Learners will refer to all the enzymes involved in the process and state the importance of each enzyme in the progression of the semi-conservative replication process. Learners will discuss in detail the various causes and consequences of variation at each stage in replication and the impact of these changes. Learners will explain the effects of variation in terms of phenotype and genotype, and how this is useful in a forensic context.

**For pass standard**, learners must explain the structure of DNA and the mechanism of DNA replication. This will include reference to all the structures listed in the content and could be a diagram or computer-generated diagram (labels must be learners' own and annotations must be explanatory). Learners will explain why regulation of DNA replication is necessary. They will outline the main causes of variation in DNA and the regulatory steps that manage the effects of this variation. Reference must be made to mutations, copying errors and other causes of variation.

#### Learning aim B

**For distinction standard**, learners will review information from a methodical and detailed examination of the appropriateness of techniques in each particular context in the unit content, to form a conclusion about the techniques for particular modes of DNA analysis. They will describe the advantages and disadvantages of each technique and use research to discuss which techniques are currently employed in forensic analysis and why.

**For merit standard**, learners will consider why DNA may need to be extracted and how this affects the choice of extraction technique. They will describe all the techniques in the content and provide a comparative assessment to show the appropriateness of a technique in a particular context. Individual observation records should be used to evidence the skilful extraction of DNA, with emphasis on pipetting techniques and use of centrifuge. Learners will describe errors that can occur at each stage of the PCR process and use this to explain the importance of regulation of PCR.

Learners should consider and include the effects of not regulating factors such as the temperature stages, anti-contamination procedures and reagents on resulting profiles.

The extent to which they are important and how they interrelate must be discussed.

**For pass standard**, learners must use examples from the content to explain processes to extract genetic material from cells. Apparatus and reagents should be referred to. Learners will use two or more examples of biological material. Along with evidence generated by learners, for example lab notes and photos, individual observation records should be used to evidence the competent extraction of DNA. The level of competency can be assessed according to accurate use of equipment and reagents, demonstrating good laboratory practice and competent use of laboratory equipment. Learners will carry out PCR and use the outcomes to demonstrate understanding of the stages of PCR and explain why DNA samples need to be amplified. Learners will refer to quantity of samples required for certain types of analysis (RFLP restriction fragment length polymorphism versus STR analysis), and the destruction of DNA samples by certain modes of analysis.

### Learning aim C

**For distinction standard**, learners will demonstrate a thorough understanding of DNA types and polymorphisms in their outcomes, evaluating the DNA analytical methods carried out. Learners will show an awareness of statistical considerations and comment accurately on how they can affect the validity of DNA evidence in court.

**For merit standard**, learners will communicate their findings from the practical work and must refer to practical outcomes in their assessment of how DNA analysis can be used in the identification of an individual. Communication can be written or verbal. Learners could produce an audio recording. If the report is not recorded, there must be an observation record showing the level of detail in the verbal report. The level of skill can be measured by their ability to communicate clear outcomes and/or respond to questions on the outcomes. Learners should discuss the scientific basis of the tests carried out, including reference to mechanisms of DNA restriction enzyme analysis and factors affecting separation of DNA using gel electrophoresis. They can use a crime scene scenario.

**For pass standard**, learners will use observation records to evidence the analysis of DNA using restriction enzyme analysis. Learners will carry out the practical and report on the outcomes in order to identify and classify the DNA sample. Learners will produce a basic report identifying the tests carried out and accurately identifying the DNA sample.

### Learning aim D

**For distinction standard**, learners will produce evaluations that can relate to validity (illustrating discriminating strength) and integrity (prevention of contamination) of the DNA data. Learners will refer to the STR loci used in the National DNA Database. Learners will comment on privacy and legal issues for DNA collected as part of a criminal investigation, leading to an overall assessment on the validity of DNA data usage.

**For merit standard**, learners must explain the legislation that governs the circumstances under which DNA data can be collected and stored. They will refer to legislation and how well it enables control and safety of the DNA information. It is expected that explanations make reference to all the legislation listed in the content in order to explain the restrictions in the use of DNA data. Learners could choose to present their evidence in the context of case studies or historical forensic cases they have researched.

**For pass standard**, learners will provide a basic description of the DNA database, stating what it is, the history of the database and how it is used to identify or eliminate individuals in a criminal investigation. Learners do not need to give examples of profiles; however, they must show how the DNA data is used in a forensic investigation.

## Links to other units

This unit links to:

- Unit 1: Principles and Applications of Science I
- Unit 2: Practical Scientific Procedures and Techniques
- Unit 3: Science Investigation Skills
- Unit 4: Forensic Investigation Procedures in Practice
- Unit 8: Physiology of Human Body Systems
- Unit 14: Forensic Anthropology and Archaeology
- Unit 16: Microbiology and Microbiological Techniques.

## Employer involvement

This unit would benefit from employer involvement in the form of:

- visits for learners to view commercial equipment used for extracting and carrying out genetic engineering techniques, as well as more advanced techniques not possible in centres' laboratories
- visits from research scientists to give talks about their current research projects.

# Unit 14: Forensic Anthropology and Archaeology

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

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## Unit in brief

Learners study the use of forensic anthropology and archaeology in forensic investigation and cover the main techniques used to recover buried human remains and identify them.

## Unit introduction

Anthropology and archaeology are specialist disciplines that can be used forensically in criminal investigations and by disaster rescue and recovery agencies. Specialists in these fields assist in situations such as homicides and mass fatalities, for example mass graves, genocide and disaster recovery. Their job is to recover human remains and to confirm their subsequent identification. Anthropologists and archaeologists can also be called in by the police and other agencies, such as councils, to use their knowledge and skills in recovering, identifying and possibly discovering the age of the individual using bone evidence found on construction and development sites.

In this unit, you will gain an understanding of the roles of the forensic anthropologist and archaeologist and the techniques used in forensic investigations. You will gain knowledge on the main techniques and methods used for detecting human burials, excavation, recovery and identification of the remains. You will explore the archaeological principles such as stratigraphy and the methods of locating and assessing sites such as burial locations. You will gain knowledge of the excavation methods involved and how artefacts and remains are recorded. You will appreciate the role of the anthropologist and their importance in forensic investigation, how they assess the number of individuals and possible causes of death with the study of trauma and diseases that can leave their trace on the bones. You will gain an understanding of physical anthropology and use skills to identify human skeletons, learning the skeletal anatomy and gaining examination skills to note physical markers that can be used to form a biological profile to identify the sex, age, race and stature of an individual.

This unit will give you valuable insights and skills that will be useful in applying for courses in higher education such as forensic science, anthropology and archaeology. You will gain an appreciation of the use of this work, which may be of benefit for employment in industries and businesses such as policing, scene of crime work, forensic science, research and fieldwork positions.

## Learning aims

In this unit you will:

- A** Understand the roles and responsibilities of forensic anthropology and archaeology in forensic investigation
- B** Explore archaeological techniques used to recover buried human remains in forensic investigation
- C** Explore techniques and observations used in forensic anthropology to identify human remains in forensic investigation.

## Summary of unit

Learning aim	Key content areas	Recommended assessment approach
<b>A</b> Understand the roles and responsibilities of forensic anthropology and archaeology in forensic investigation	<p><b>A1</b> Role of the forensic anthropologist and archaeologist</p> <p><b>A2</b> Professional relationships of a forensic anthropologist and archaeologist</p> <p><b>A3</b> Ethical considerations of forensic anthropology and archaeology in practice</p> <p><b>A4</b> Uses of forensic anthropology and archaeology in forensic investigation</p>	<p>Research based on case studies for visual presentation. Supported by observation documentation completed by the assessor.</p> <p>A written report with a vocational aspect on the importance and value of forensic anthropology and archaeology in forensic investigation.</p> <p>Supported with research notes.</p>
<b>B</b> Explore archaeological techniques used to recover buried human remains in forensic investigation	<p><b>B1</b> Equipment and health and safety awareness</p> <p><b>B2</b> Site detection techniques</p> <p><b>B3</b> Site assessment techniques</p> <p><b>B4</b> Site excavation methods</p> <p><b>B5</b> Site recovery methods</p>	<p>Research and investigative report based on vocational scenario case studies of a simulated burial scene.</p>
<b>C</b> Explore techniques and observations used in forensic anthropology to identify human remains in forensic investigation	<p><b>C1</b> Skeletal and skull anatomical knowledge</p> <p><b>C2</b> Identification, measuring and analytical techniques</p> <p><b>C3</b> Physical identification markers</p> <p><b>C4</b> Skeletal abnormalities and effects of injuries and disease on bone</p>	<p>An investigative report of an examination of skeletal and skull remains; evaluating results and explaining and evaluating identification techniques used in forensic investigation.</p> <p>Identification of various skeletal and skull anatomy.</p> <p>Supported with practical sheets and observation documentation by assessor.</p>

## Content

### Learning aim A: Understand the roles and responsibilities of forensic anthropology and archaeology in forensic investigation

#### A1 Role of the forensic anthropologist and archaeologist

- Forensic anthropologist:
  - identifying human and non-human remains from skeletal inventory, decomposed and fragmented
  - assessing number of individuals
  - creating a biological profile, to include sex, age, race, stature
  - analysis of peri-mortem trauma, to include identification of force type trauma
  - expert witness.
- Forensic archaeologist:
  - detection and assessment of sites
  - excavation and recovery of human remains and artefacts, to include the theory of stratigraphy and timelines
  - expert witness.

#### A2 Professional relationships of a forensic anthropologist and archaeologist

- Forensic anthropologist:
  - scene work, e.g. forensic archaeologists, odontologists, police, scene of crime officers, Home Office pathologist
  - laboratory work, e.g. pathologists and mortuary technicians, legal – Crown Prosecution Service (CPS), coroner’s office.
- Forensic archaeologist:
  - scene work, e.g. forensic anthropologists, police, scene of crime officers, Home Office pathologist, agencies such as Forensic Search Advisory Group (FSAG), Police Search Advisors (PoSAs)
  - legal – CPS, coroner’s office.

#### A3 Ethical considerations of forensic anthropology and archaeology in practice

- Human rights and consideration of the remains.
- Implications of identification on families.
- Cultural requirements regarding the remains.
- Use of remains in research and education.
- Psychological impact of work on the practitioner, e.g. dealing with homicides involving minors.

#### A4 Uses of forensic anthropology and archaeology in forensic investigation

- Types of offences – serious crimes such as murders, genocide and mass graves, e.g. Rwandan genocide, war in former Yugoslavia – Bosnia, Iraq genocides (2003); political abductions, e.g. South America; sexual crime, other non-offences such as mass disasters, e.g. 2004 Indian Ocean earthquake and tsunami, landslides and earthquakes.

### Learning aim B: Explore archaeological techniques used to recover buried human remains in forensic investigation

#### B1 Equipment and health and safety awareness

- Use of personal protective equipment (PPE).
- Equipment for digging, measuring, surveying and packaging.
- Major incident equipment, e.g. setting of common approach pathway (CAP), cordons, tents, screens, logging of personnel.
- Health and safety awareness, to include diseases from corpses, insects and animals, such as rodents, and poisoned and contaminated soil.

**B2 Site detection techniques**

- Intelligence data, e.g. witnesses, CCTV imaging, palynology and soil data from suspect.
- Assessment of landscape, to include cartography and accessibility of sites.
- Physical techniques, e.g. aerial photography, LiDAR (light detection and ranging), satellite imagery, geophysical surveys, cadaver-detecting dogs, field walking, environmental indicators such as pH, plant types and growth, mounds, hollows.

**B3 Site assessment techniques**

- Identifying grave limits, to include subsoil differences, outline of mounds and hollows, plant differences.
- Mass graves, to include control trenches (stratigraphic data), advantages and disadvantages of probing (search for bodies and depth) and exploratory trenches.

**B4 Site excavation methods**

- Individual and mass grave excavation differences – logistics in personnel and equipment.
- Surface area cleaning and recording.
- Initial trench (sondage).
- Recording and separation of layers with observation of material, e.g. colour, texture, dryness and moistness, compactness.
- Recording of soil and infill profile, to include connection with stratification method and time, link to taphonomic stage of body, materials found in soils such as tree and plant roots, dendrochronology.
- Sieving of material – recovery of botanical and entomological material.
- Half-sectioning method.
- Recording and documentation of items in situ.
- Grave cuts – digging implement marks.
- Potential destruction of site in recovery of body.

**B5 Site recovery methods**

- Sequence of documentation and recording before individual manipulation and cleaning of remains and artefacts.
- Recording process, e.g. fixed reference points, Electronic Distance Measurer (EDM), triangulation, laser scanning, photographic, video recording and documentation of removal of body.
- Methods of removal, to include whole lift and individual lifting.
- Professional recovery advice – pathologist and forensic anthropologist.
- Exhibits officer's role and responsibilities with evidence.
- Recording of grave without human remains, to include:
  - measurement and recording
  - recovery of artefacts
  - assessment of bioturbation.

**Learning aim C: Explore techniques and observations used in forensic anthropology to identify human remains in forensic investigation****C1 Skeletal and skull anatomical knowledge**

- Skeleton bone function – support, protection, movement and storage, e.g. fat, calcium, phosphorus.
- Classification of bones, to include:
  - main bone shape types – long bones, short bones, flat bones, irregular bones
  - axial and appendicular skeleton
  - joint types, e.g. fibrous, cartilaginous, synovial
  - joint types based on shape
  - structure of bones.

- Bone markings, to include:
  - muscle and ligament attachment
  - joint projections
  - openings and depressions for nerve and blood vessels.
- Microscopy anatomy, e.g. osteocytes, lacunae, lamellae, central (Haversian) canals.
- Bone formation, to include:
  - growth and regrowth, e.g. ossification, osteoblasts, bone remodeling
  - bone fractures, e.g. compression, depressed, impacted, comminuted, spiral and greenstick.

## **C2 Identification, measuring and analytical techniques**

- Identification via ante-mortem and post-mortem data, to include:
  - family and witnesses
  - dental and medical records (including radiographic images)
  - fingerprint and DNA records
  - photographic and video images
  - personal item data such as jewellery and clothes
  - other identification, e.g. tattoos, medical implants, passport details, passenger lists.
- Measuring techniques, to include:
  - visual examination (anthroposcopy) with magnification and radiography
  - bone measurement (osteometry) – visual examination, calipers, osteometric boards.
- Analytical techniques, to include:
  - photographic superimposition – skull and dental imaging
  - facial reconstruction, e.g. clay and computer imagery, ageing
  - chemical analysis, e.g. mass spectroscopy – isotopic analysis of bones, radiocarbon dating, comparison with environmental data
  - histology – microstructure of bones and teeth.
- Limitations of anthropology methods, to include:
  - population variances
  - diet
  - environmental factors
  - dual heritage persons
  - indigenous populations and movements of people – rarer occurrence in isolated communities due to globalisation
  - degraded DNA and damaged bones.

## **C3 Physical identification markers**

- Skeletal inventory – laying out of bones, number of individuals.
- Biological profile, to include sex markers, skull analysis, age markers, race markers, stature estimation with appropriateness of use.
- Other markers, e.g. dental data, photographic imaging and facial reconstruction, DNA, fingerprints.

## **C4 Skeletal abnormalities and effects of injuries and disease on bone**

- Congenital abnormalities, e.g. club foot, extra digits and ribs, spina bifida, dwarfism.
- Other abnormalities, e.g. scoliosis, flat head syndrome, severe cleft palate.
- Ante-mortem and peri-mortem injuries, to include:
  - bone healing behaviour
  - musculoskeletal injury markers, e.g. exostoses, spicules of bone growth.
- Post-mortem damage.
- Types of injuries, to include:
  - projectile
  - blunt
  - sharp.

- Estimation of force trajectory from wound marks.
- Physical injuries, e.g. amputations, medical implants.
- Disease markers, e.g. bone cancer, tumours, osteoporosis, severe anaemia, rickets, leprosy, infectious diseases.

## Assessment criteria

Pass		Merit	Distinction
<b>Learning aim A: Understand the roles and responsibilities of forensic anthropology and archaeology in forensic investigation</b>			<b>A.D1</b> Evaluate the value of forensic anthropology and archaeology to forensic investigation.
<b>A.P1</b> Describe the role of forensic anthropology and archaeology in forensic investigation.	<b>A.M1</b> Explain the importance of forensic anthropology and archaeology in forensic investigation.		
<b>Learning aim B: Explore archaeological techniques used to recover buried human remains in forensic investigation</b>			<b>B.D2</b> Evaluate the use of different scientific techniques used in the recovery of human remains.
<b>B.P2</b> Carry out an investigation of a simulated burial scene. <b>B.P3</b> Explain how scientific techniques are used in the investigation, excavation and recovery of buried human remains.	<b>B.M2</b> Assess the effectiveness of these scientific techniques in forensic investigation.		
<b>Learning aim C: Explore techniques and observations used in forensic anthropology to identify human remains in forensic investigation</b>			<b>C.D3</b> Evaluate the use of different scientific techniques in the identification of human remains.
<b>C.P4</b> Examine skeletal and skull anatomy. <b>C.P5</b> Explain how observations and identification techniques are used to identify human remains in forensic investigation.	<b>C.M3</b> Assess the effectiveness of the scientific techniques used in identifying human remains.		

## Essential information for assignments

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

There is a maximum number of three 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)

## Further information for teachers and assessors

### Resource requirements

For this unit, learners must have access to:

- maps/Google Earth™
- educational resources of male and female human skeletons, skeletal bones and skulls from different sexes, ages and ethnicity
- measuring equipment, including osteometric boards
- a place for burial of artefacts, digging equipment, measuring and recording equipment, sieves, plastic sheeting and wheelbarrows for the practical excavation.

If centres do not have the facilities to arrange the practical of assessing and evacuating buried artefacts, such as educational (mock) bones and other evidence, then the assessment of the burial site can be supplemented by using given information on the scenario with cartography and/or photographs/sketches. Learners can use this to show how they would search for the burial site and on finding it, what techniques they would use to assess the landscape and recover the remains.

If no educational bones or skeletons are available, the practical assessment of identifying skeletal remains can be carried out using real-size photographs, radiographs (x-rays) or internet images with a measuring tool.

It is expected that where possible, appropriate investigative work will be carried out in this unit. Health and safety, and ethical considerations are paramount, and teachers must ensure that the necessary risk assessments are carried out and communicated to their learners. Refer to CLEAPSS and/or your centre's health and safety regulations if in doubt about any of the investigative work that has been suggested.

For this unit, teachers should select and use appropriate simulated forensic samples, where appropriate, for learners to investigate, that adhere to health and safety practices in place at the centre.

### Essential information for assessment decisions

#### Learning aim A

**For distinction standard**, learners must weigh up the value that forensic anthropology and archaeology bring to forensic investigation. They can compare and contrast the two areas and the benefits and limitations of the disciplines in forensic investigation. Learners must support their views with valid examples; these can include legal benefits and limitations as well as evidential value.

**For merit standard**, learners will explain in a detailed report how important forensic anthropology and archaeology are to forensic investigation. Learners can draw on their research studies and other information to give valid examples that show evidence of their conclusions on the contribution of these areas to forensic investigation. Learners will cover the ethics of the forensic anthropologist and archaeologist and how these disciplines have evolved with human rights and legal statutes, as well as evolving to be sympathetic to cultural differences and personal values.

**For pass standard**, learners will perform a visual presentation and show research in a report describing the use of forensic anthropology and archaeology in forensic investigation. Learners must cover identification, assessment of number of individuals, biological profiles, detection and assessment of sites, evacuation and recovery of human remains, stratigraphy and timelines and expert witnesses. Learners will cover the professional relationships of the forensic anthropologist and archaeologist in a forensic investigation.

### Learning aim B

**For distinction standard**, learners must give detailed evidence, reviewing the advantages and disadvantages of the scientific techniques used in recovering human remains. Further examples of techniques, other than the ones used in their scenarios, can be discussed to strengthen the breadth and depth of their evaluation, for example setting up of common approach pathways, disease and contaminated soil awareness, other physical techniques of detecting the scene, use of intelligence data, differences in dealing with single and mass graves and recovery methods.

**For merit standard**, learners will need to give detailed, valid reasons, assessing how effective the scientific techniques used in their scenario-led examinations are. This will include assessment of their site equipment and health and safety awareness, together with discussing how effective their site detection and assessment techniques were and their excavation and recovery methods. Learners can refer to their scene documentation, sketches and photographs etc. to illustrate their reasoning.

**For pass standard**, learners will investigate a scenario-led assessment of a simulated burial site. Learners will write an investigative report explaining how scientific techniques are used in the recovery of buried human remains, including site awareness, detection, assessment, evacuation and recovery techniques. A written report for the simulated burial is appropriate here and can be brought into the scenario given to learners, as if being written for court purposes. Scene documentation, drawings and sketches, and photographs would be beneficial to learners' reports.

### Learning aim C

**For distinction standard**, learners must give detailed evidence, reviewing the advantages and disadvantages of the scientific techniques used in identifying human remains. Further examples of techniques, other than the ones used in their scenarios, can be discussed to strengthen the breadth and depth of their evaluation, for example chemical analysis, ethnicity, DNA, fingerprint, dental identification and facial reconstruction, effects of genetics, for example dual heritage; population variances, trauma and disease on bones.

**For merit standard**, learners will need to give detailed, valid reasons, assessing the effectiveness of the scientific techniques that were used in their scenario-led examinations. This will include assessment of the observation and identification techniques, commenting on how effective the visual and measurement examinations are to helping identify the bones and finding out the number of individuals and their biological profile. Learners can refer to their laboratory documentation, sketches and photographs etc. to illustrate their reasoning.

**For pass standard**, learners will investigate a scenario-led assessment of a practical identification and examination of skeletal bones and skulls. They will write an investigative report and explain how the scientific techniques they used have helped in identifying human remains. This will include the observation and identification techniques, for example visual examination and bone measurement, identification of bones, assessment of number of individuals and biological profile. A written report for the simulated identification of bones is appropriate here and can be brought into a scenario given to learners, as if being written for court purposes. Laboratory documentation, drawings and sketches and photographs would be beneficial to learners' reports.

## Links to other units

This unit links to:

- Unit 1: Principles and Applications of Science I
- Unit 2: Practical Scientific Procedures and Techniques
- Unit 3: Science Investigation Skills
- Unit 4: Forensic Investigation Procedures in Practice
- Unit 8: Physiology of Human Body Systems
- Unit 9: Environmental Forensics
- Unit 13: Forensic Genetics
- Unit 16: Microbiology and Microbiological Techniques.

## Employer involvement

This unit would benefit from employer involvement in the form of:

- visits from specialists such as archaeologists and anthropologists, police and scene of crime officers
- visits to anatomical museums and archaeological excavation sites open to the public, as well as other institutions, e.g. colleges or universities with resources such as a mass spectrometry machine and anthropological and archaeological equipment.



# Unit 15: Practical Chemical Analysis

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

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## Unit in brief

This unit covers quantitative analysis, spectroscopy, chromatography and industrial quality-assurance procedures.

## Unit introduction

Chemical analysis has many applications in manufacturing, particularly in product quality control, the monitoring of production processes and drug development processes in the pharmaceutical industry. In addition, chemical analysis of body fluids is critical to the diagnosis of disease and to policing the use of banned substances in sport. For all major sporting events a team of analytical chemists is active behind the scenes, analysing a variety of body fluids for microscopic traces of illegal and banned substances. Chemical analysis is also used to monitor air and effluent for pollutants and when testing building land for toxic contaminants.

In this unit, you will apply your knowledge of extraction and quantitative techniques to the analysis of the components of natural or commercial products. In addition to the component being analysed, there are usually other substances present that complicate the analysis and require the use of specially adapted procedures.

You will learn how to interpret the information from a range of spectroscopic and instrumental chromatographic methods, which have become the techniques of choice for many industries. For example, a pharmaceutical laboratory technician will be trained to routinely use instrumental techniques, including infrared and ultraviolet-visible spectroscopy, gas chromatography and high-performance liquid chromatography techniques, with which you will become familiar.

The experience gained from this unit will be a useful introduction to many analysis techniques used in laboratories and, should you progress to higher education, you will use them on courses related to chemistry, biochemistry, sports science, biomedical science, public health, environmental and forensic science.

## Learning aims

In this unit you will:

- A** Investigate quantitative analysis on the components of matrices to determine their composition
- B** Investigate spectroscopic techniques to identify compounds and determine concentrations
- C** Investigate chromatographic techniques to identify components and determine the amounts present in samples.

## Summary of unit

Learning aim	Key content areas	Recommended assessment approach
<b>A</b> Investigate quantitative analysis on the components of matrices to determine their composition	<b>A1</b> Quantitative analysis of products	A portfolio of method sheets and calculated results for the three analyses. A report comparing 'primary and secondary titrimetric standards', analysis of specific errors and how accuracy may be affected by analytes being part of a matrix.
<b>B</b> Investigate spectroscopic techniques to identify compounds and determine concentrations	<b>B1</b> Beer-Lambert applications <b>B2</b> Organic structure elucidation	A portfolio of method sheets, calibration graphs and calculated results. Completed exercises on use of percentage composition and mass spectrometry to determine molecular formula, evidence of identification of the class of compound, giving rise to particular infrared spectra, matching $^1\text{H}$ and $^{13}\text{C}$ NMR spectra to structural formulae of simple organic molecules. An account of how two unknown organic compounds have been identified from their percentage composition, mass spectra, infrared spectra and $^1\text{H}$ and $^{13}\text{C}$ NMR spectra.
<b>C</b> Investigate chromatographic techniques to identify components and determine the amounts present in samples	<b>C1</b> Gas chromatography (GC) <b>C2</b> High-performance liquid chromatography (HPLC)	Description of how the techniques GC and HPLC work. A portfolio of qualitative and quantitative interpretation of chromatograms and peak area results for HPLC and GC. A report describing how an HPLC method would be developed and how either an HPLC or GC procedure would be modified to give optimum separation of peaks.

## Content

### Learning aim A: Investigate quantitative analysis on the components of matrices to determine their composition

#### A1 Quantitative analysis of products

- Determination of the copper content of brass:
  - digestion of brass in acid and making it up to a known volume
  - colorimetric determination of copper content, to include matched standards.
- Bicarbonate content of bottled water:
  - standardisation of 0.1 mol dm<sup>-3</sup> hydrochloric acid by titration with sodium carbonate (bromophenol blue indicator)
  - quantitative dilution of 0.1 mol dm<sup>-3</sup> hydrochloric acid to make 0.01 mol dm<sup>-3</sup> hydrochloric acid
  - pH titration of bottled water with standardised 0.01 mol dm<sup>-3</sup> hydrochloric acid.
- Iron(II) content of iron tablets:
  - extraction of Fe<sup>2+</sup> by grinding tablets and heating with water
  - standardisation of potassium manganate(VII) with sodium ethane dioate
  - titration of Fe<sup>2+</sup> by titration with potassium manganate(VII).

### Learning aim B: Investigate spectroscopic techniques to identify compounds and determine concentrations

#### B1 Beer-Lambert applications

- Colorimetry or spectrometry in the visible region by adding a colour reagent.
- Colorimetry or spectrometry by intensification of Cu<sup>2+</sup> colour by adding ammonia and use of matched standards.
- Interpretation of data from quantitative infrared spectroscopy.
- Interpretation of data from quantitative ultraviolet spectroscopy.

#### B2 Organic structure elucidation

- Determination of empirical formula from % elemental composition.
- Mass spectroscopy:
  - block diagram of instrumentation
  - use of mass to charge ratio  $\frac{m}{z}$
  - determination of the molecular ion peak
  - determination of molecular formula from molecular ion peak and empirical formula
  - simple fragmentation to include presence of peak at 15 for methyl.
- Drawing all possible isomeric structures for molecules of general formula:
  - C<sub>n</sub>H<sub>2n+2</sub> – alkane/branched alkane
  - C<sub>n</sub>H<sub>2n</sub> – alkene or cycloalkane
  - C<sub>n</sub>H<sub>2n+2</sub>O – alcohol or ether
  - C<sub>n</sub>H<sub>2n</sub>O – aldehyde, ketone or alkenol
  - C<sub>n</sub>H<sub>2n</sub>O<sub>2</sub> – carboxylic acid or ester
  - aromatic compound – low number of hydrogens.

- Infrared spectroscopy:
  - spectra in terms of wavenumber ( $\text{cm}^{-1}$ ) and transmission
  - energy used to make bonds bend and stretch
  - Fourier transform infrared spectroscopy (FTIR)
  - principles of operation
  - sample preparation, to include:
    - an awareness of use of agate mortar and pestles in preparation of solid samples
    - transparency of halide salts
    - common use of NaCl plates exclusion of moisture
    - liquid films
    - solid mulls
    - KBr discs
    - diamond ATR
    - solution cell for quantitative work
    - gas cell
  - correlation chart relating wavenumbers to functional groups, to include:
    - C-H – alkanes, alkenes and aromatics
    - C=C – alkenes
    - O-H – alcohols and carboxylic acids, including peak shape
    - C=O – for aldehydes, ketones, esters, carboxylic acids
  - identification of unknown matrices by matching positions and relative transmission values of the peaks.
- Proton ( $^1\text{H}$ ) and ( $^{13}\text{C}$ ) NMR spectroscopy:
  - radio waves of appropriate frequency in the presence of large magnetic field of correctly tuned magnitude cause nucleus to spin-flip
  - presence of electron density in covalent shields  $^1\text{H}$  or  $^{13}\text{C}$  from magnetic field – greater field needed to bring nucleus into resonance
  - number of chemically equivalent protons or carbon atoms in a molecule
  - relation of the number of low-resolution peaks to the number of chemically distinct protons ( $^1\text{H}$  NMR) or carbon atoms ( $^{13}\text{C}$  NMR)
  - relation of the number of low-resolution peaks to the number of chemically distinct protons ( $^1\text{H}$  NMR) or carbon atoms ( $^{13}\text{C}$  NMR)
  - relation of degree shielding to chemical shift,  $\delta$ , [0 for tetramethylsilane (TMS) and around 10 for an aldehyde proton]
  - correlation charts
  - relation of area under peak (integration) to the number of atoms in the molecule giving rise to the peak
  - simple splitting patterns and use of the  $n + 1$  rule
  - distinguishing between isomeric structures on the basis of NMR.

### **Learning aim C: Investigate chromatographic techniques to identify components and determine the amounts present in samples**

#### **C1 Gas chromatography (GC)**

- Difference between gas-solid chromatography (GSC) and gas-liquid chromatography (GLC).
- Block diagram of GC and function of components.
- Mobile phase – carrier gases.
- Packed columns (becoming less common) and capillary columns.
- Stationary phase – solid ceramic material in GSC, viscous liquid coating solid support material in GLC with packed columns, viscous liquid coating the inside of capillary tubing in capillary GC, oven surrounding the column.
- Injection – higher temperature than oven temperature, septum, method of filling a microsyringe, known sample size, headspace, autosampler.

- Detector – flame ionisation detector (FID) (most common), additional gas cylinders needed for FID, awareness that there are other types of detector.
- Display/output:
  - old instruments may have a monitor and chart paper
  - modern instruments are PC driven and chromatograms may be printed from a computer printer.
- Data obtained:
  - optimum resolution of the peaks
  - retention time as a measure of a component's identity (qualitative)
  - use of spiking to confirm the identity of a component
  - area under the peak as a quantitative measure
  - use of an internal standard in quantitative work
  - calibration graph based on ratio area due to known concentrations/area due to internal standard
  - type of samples/analytes for which this technique is appropriate
  - industries/organisations using GC
  - awareness of the possibility of coupling with mass spectroscopy.
- Parameters that may be altered:
  - different columns chosen to match the analytes
  - use of internet methods and column manufacturers' data in method development
  - oven temperature:
    - the higher the temperature, the faster the molecules move – lowers retention time and separation
    - fixed temperature setting
    - programmed to increase in the course of a run (where one or more component may have a much longer retention time)
  - different detectors for certain components.

## **C2 High-performance liquid chromatography (HPLC)**

- Block diagram of HPLC and function of components – system under pressure to make the separation of components faster.
- Normal phase (polar column and non-polar solvent) and reverse phase (non-polar column and polar solvent).
- Mobile phase – degassed solvent chosen to optimise separation, methods of degassing, problems if solvent is not degassed, design of solvent bottles, isocratic elution, gradient elution.
- Stationary phase – column selected to match analyte.
- Injection – the need to degas samples, use of the rheodyne valve, injection loop
  - method of filling a microsyringe
  - autosampler.
- Detector:
  - ultraviolet – most common for organic molecules
  - awareness that there are other types of detector.
- Display/output:
  - old instruments may have an integrator connected to a chart recorder
  - modern instruments are PC driven and chromatograms may be printed from a computer printer.

- Data obtained:
  - retention time as a measure of a component's identity (qualitative)
  - optimum resolution of the peaks
  - use of spiking to confirm the identity of a component
  - area under the peak as a quantitative measure
  - construction of a calibration curve from peak areas of solutions of known concentration
  - determination of the concentration of an analyte from its peak area and a suitable calibration curve
  - type of samples/analytes for which this technique is appropriate
  - industries/organisations using HPLC
  - awareness of the possibility of coupling with mass spectroscopy.
- Parameters that may be altered:
  - different columns chosen to match the analytes
  - use of internet methods and column manufacturers' data in method development
  - different solvents
  - virtually limitless possible combinations of columns/solvents, allowing almost any mixture to be separated
  - gradient elution – where one or more components may have a much longer retention time than the other components of the mixture
  - wavelength of the UV detector
  - use of a different detector if UV is not suitable.

## Assessment criteria

Pass	Merit	Distinction
<b>Learning aim A: Investigate quantitative analysis on the components of matrices to determine their composition</b>		<b>A.D1</b> Analyse errors specific to each method and how the inclusion of analyses in matrices may affect the accuracy of the results.
<p><b>A.P1</b> Demonstrate accurately the amount of analyte in matrices.</p> <p><b>A.P2</b> Describe the composition of the matrices analysed.</p>	<p><b>A.M1</b> Discuss the measures taken to ensure accuracy in determining the amount of analyte in the matrices.</p> <p><b>A.M2</b> Compare the use of primary and secondary titrimetric standards.</p>	
<b>Learning aim B: Investigate spectroscopic techniques to identify compounds and determine concentrations</b>		<b>B.D2</b> Analyse the process of determining the structures of simple organic compounds from their percentage composition, infrared spectra, mass spectra, <sup>1</sup> H NMR and <sup>13</sup> C NMR spectra.
<p><b>B.P3</b> Demonstrate accurately the concentrations of solutions using the Beer-Lambert law.</p> <p><b>B.P4</b> Describe the key features of a range of spectra of unknown compounds to determine the identity these compounds.</p>	<p><b>B.M3</b> Explain correctly the structures of simple organic compounds from their percentage composition, infrared spectra, mass spectra, <sup>1</sup>H NMR and <sup>13</sup>C NMR spectra.</p>	
<b>Learning aim C: Investigate chromatographic techniques to identify components and determine the amounts present in samples</b>		<b>C.D3</b> Analyse how the separation from an instrumental chromatographic technique may be optimised.
<p><b>C.P5</b> Explain the operation and applications of capillary GC and HPLC instrumentation and measurements.</p> <p><b>C.P6</b> Demonstrate accurately the identity and amount of analytes using qualitative and quantitative GC and HPLC data.</p>	<p><b>C.M4</b> Discuss how a method for finding the amount of a given organic compound in a given sample by HPLC could be developed.</p>	

## Essential information for assignments

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

There is a maximum number of three 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.M3, B.D2)

Learning aim: C (C.P5, C.P6, C.M4, C.D3)

## Further information for teachers and assessors

### Resource requirements

For this unit, learners must have access to:

- a well-equipped laboratory with a fume cupboard
- colorimeters for practical spectroscopy work
- infrared spectrometers (likely to be FTIR) and ultraviolet/visible spectrometers in operation
- qualitative and quantitative data from gas chromatography (GC) and high-performance liquid chromatography (HPLC) (essential)
- GC or HPLC chromatograms relating to optimisation of a separation (or case-study material from another organisation).

It is expected that where possible, appropriate investigative work will be carried out in this unit. Health and safety, and ethical considerations are paramount, and teachers must ensure that the necessary risk assessments are carried out and communicated to their learners. Refer to CLEAPSS and/or your centre's health and safety regulations if in doubt about any of the investigative work that has been suggested.

### Essential information for assessment decisions

#### Learning aim A

**For distinction standard**, learners will analyse specific features of the three methods that may affect the results. Learners will consider why the results from these experiments may be different from those where a technician may have made solutions of pure compounds for analysis.

**For merit standard**, learners will discuss the aspects of good volumetric practice in their practical work that enabled them to accurately determine the composition of the matrices. Learners will provide a recorded (written or a sound recording) explanation of why they have repeated a flawed piece of work and their reason will be specific to the technique being carried out. Because secondary titrimetric standards are being used to determine hydrogen carbonate concentration and manganate concentration, learners will also compare the use of primary and secondary standards in context, using examples specific to the analyses. They will explain why secondary standards are being used in preference to primary standards and why the secondary standards must be standardised using primary standards.

**For pass standard**, learners will accurately measure the percentage of copper in a sample of brass by acid digestion and colorimetry, the concentration of hydrogen carbonate ( $\text{mg dm}^{-3}$ ) in a water sample by pH titration with standardised hydrochloric acid and the percentage of iron(II) in a commercial iron tablet by titration with standardised potassium manganate(VII) solution. Learners will carry out practical work independently, following standard methods provided by tutors, and they will demonstrate competence by practising good skills in weighing and in making volumetric measurements. This will be evidenced by use of an observation report or video recording. Results will be reasonably accurate. This may be evidenced by comparing learners' results with those of their classmates. Learners will research and describe the typical components of the three matrices, and provide an approximate percentage or concentration of each component. They will provide sources of reference for the information.

#### Learning aim B

**For distinction standard**, learners will present a full written analysis of the logic used to elucidate the structural formulae of the two compounds from their infrared spectra, mass spectra,  $^1\text{H}$  NMR and  $^{13}\text{C}$  NMR spectra. They will justify whether the conclusions they have reached are likely to be completely correct or whether there are justifiable options for the compounds that they have identified.

**For merit standard,** learners will correctly elucidate the structure of the compounds in a logical way, having been presented with the percentage elemental composition, infrared spectra, mass spectra,  $^1\text{H}$  NMR and  $^{13}\text{C}$  NMR spectra for two different compounds. Learners will demonstrate in writing or verbally that they have used appropriate logic to arrive at appropriate conclusions, but it may be necessary for the tutor to provide an observation report if this is not evident from their written work.

**For pass standard,** learners will carry out experiments that extend their knowledge of the applications of the Beer-Lambert law and will interpret infrared, mass,  $^1\text{H}$  NMR and  $^{13}\text{C}$  NMR spectra.

Learners will carry out two experiments from the following list, based on the Beer-Lambert law:

- use of either a colorimeter or visible spectrometer where a colour reagent is added to the standards and to the sample. Learners could determine nitrite concentration or phosphate concentration, which are both colourless before the addition of a reagent
- use of either a colorimeter or a visible spectrometer where ammonia is used to intensify the colour of  $\text{Cu}^{2+}$  standards and sample
- use of an infrared spectrometer with a solution cell
- use of an ultraviolet spectrometer to determine the concentration of a solution containing a substance (such as the nitrate ion or an organic molecule) that absorbs in the ultraviolet region of the spectrum.

Learners will follow given experimental methods and process results (plotting a calibration graph by hand or using Excel), using the graph to find the sample concentration.

Learners are likely to find the combined use of spectra to identify a compound too demanding. Learners will demonstrate the relevant skills separately for each different type of spectrum. They will calculate empirical formula from percentage elemental composition and determine molecular formulae from the compound's mass spectrum for at least two compounds. Additionally learners will use the key feature of infrared spectra, namely the absence or presence of peaks for O-H, C-H, C=O, C=C and C-O, in order to determine which spectrum corresponds to an alkane, alkene, alcohol, ester, carboxylic acid, aldehyde and ketone. Learners will also be given the displayed structural formulae of four simple compounds to work out the number of chemically equivalent hydrogens and carbons and proximity to an electronegative atom in order to match  $^1\text{H}$  and  $^{13}\text{C}$  NMR spectra to the appropriate structural formulae.

### Learning aim C

**For distinction standard,** learners will analyse either how the separation in a GC or an HPLC method would be optimised, including how increasing/decreasing temperature would affect separation in GC, or how polarity of solvent would affect separation in HPLC. For GC, learners will analyse column selection, oven temperature and temperature programming in relation to the separation of given compounds. For HPLC, learners will analyse the effects of changing the solvent composition (isocratic elution) and the benefits of gradient elution compared with isocratic elution. They will analyse how the UV detector wavelength would be set for HPLC. Learners will be aware that the baseline noise would need to be smoothed. The analysis could be based on experiments (where the centre has a functioning GC or HPLC) or on case study data (such as chromatograms run under different conditions) relating to optimising a specific separation. Learners could extend the discussion on HPLC method development, used at merit standard, analysing variables in more depth.

**For merit standard,** learners will discuss how an HPLC method for a specific, given analysis may be written and developed, in order to demonstrate the depth of their understanding of instrumental chromatography. This is likely to include a discussion of their initial research on possible HPLC methods that could be adapted and how they would determine whether the methods identified would work for the given analyte. They will discuss the most appropriate solvents and columns to use, the initial experiments that they would carry out and the further refinements that may be needed. Learners may carry out the practical work related to method development if the centre has

a functioning HPLC instrument, but this is not essential as it is an understanding of how a method could be developed that is required. In all merit-level work, learners will acknowledge the sources of information.

**For pass standard**, learners will draw, on paper or computer, a block diagram of a capillary GC and an HPLC instrument and explain the function of the components. A photocopy from a book or a downloaded diagram is not acceptable. Learners will research at least two specific examples of how HPLC is used and two specific examples of how GC is used. Learners will explain how the techniques are used in the four applications.

Learners will accurately identify the components of a mixture from retention times and/or spiking results for a GC chromatogram/chromatograms and the components of a mixture from retention times and/or spiking results for an HPLC chromatogram/chromatograms. They will accurately use chromatograms or peak area data from either a GC or an HPLC chromatogram in order to determine the amount of an analyte present. This could involve the production of a calibration graph for the analyte. Learners may interpret their own data from GC and HPLC experiments or interpret given data.

### Links to other units

This unit links to:

- Unit 2: Practical Scientific Procedures and Techniques
- Unit 3: Science Investigation Skills.

### Employer involvement

Centres may involve employers in the delivery of this unit if there are local opportunities to do so. A visit to, or a speaker from, any commercial laboratory, no matter how small, will add value to this unit. Suitable laboratories include those analysing raw materials or products in the following manufacturing industries: food and drink, dairy, pharmaceuticals, polymers, dye, paints, coatings, road surfacing, ceramics, refractories, bulk chemicals, fuels and lubricants, cement kiln fuel, animal feed, transformer oils, cleaning products, fertilisers, wastewater treatment. In addition, there are laboratories that undertake sub-contracted and accredited analysis, for example of water, soil, foodstuffs and petroleum products that offer wide-ranging expertise of benefit to learners.



# Unit 16: Microbiology and Microbiological Techniques

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

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## Unit in brief

Learners will explore the characteristics of microorganisms and develop practical skills relating to their study, including microscopy and the practice of aseptic technique.

## Unit introduction

In this unit, you will discover how essential microorganisms are. They have been exploited for beneficial use for a long time, but more recently biotechnology has given microorganisms an important role in agriculture, food production and medicine. This is not to forget that some microorganisms can be disease causing and result in impaired health or even death for millions of people every year. Biomedical scientists are involved in a constant search for new antibiotics, antiseptics and preventative measures against disease-causing organisms.

Microbiology is a branch of biology that deals with microorganisms usually too small to be seen with the naked eye, including bacteria, viruses, some fungi and a group of even smaller organisms called prions. The latter are of interest because of the devastating diseases they cause in humans.

You will study microorganisms and the factors that affect their growth. You will also learn how to safely handle some types of microorganisms in a laboratory setting and develop the manipulative skills needed for good aseptic techniques, including risk analysis.

In the unit you will carry out practical work to prepare and use different types of growth media and different inoculation techniques safely. You will also experience the different methods used to measure microbial growth, as these techniques are very important in commercial laboratories. You will develop your skills using microscopes and their attachments to better be able to identify some microorganisms. Your research will ask you to look at other types of specialist microscopes, which are vital to understanding the structure of microbes.

The skills associated with microbiology are in great demand and microbiologists are at the centre of developments in areas such as biochemical and biomedical products, crop health and food production, livestock health, genetic engineering and forensic science. This unit will help you to progress to a wide range of courses in higher education including microbiology, medical microbiology, biomedical science and forensic science.

## Learning aims

In this unit you will:

- A** Understand the importance of microbial classification to medicine and industry
- B** Undertake microscopy for specimen examination in laboratories
- C** Undertake aseptic techniques to culture microorganisms
- D** Explore factors controlling microbial growth in industrial, medical and domestic applications.

## Summary of unit

Learning aim	Key content areas	Recommended assessment approach
<b>A</b> Understand the importance of microbial classification to medicine and industry	<b>A1</b> Microorganisms and infectious agents <b>A2</b> Classification <b>A3</b> Microorganisms in medicine and industry	<p>A research report using any appropriate format that covers four of the listed microorganisms.</p> <p>Practical work setting up and using light microscopes and oil immersion lenses to look at the structure of microorganisms. Scientific drawings of specimens, laboratory notebooks and practical write-ups supported by teacher observations.</p> <p>A presentation of their work which also outlines the uses and limitations of the instruments used when compared with other types of microscopy, including specimen preparation and imaging.</p>
<b>B</b> Undertake microscopy for specimen examination in laboratories	<b>B1</b> Microscopes <b>B2</b> Specimen and slide preparation <b>B3</b> Setting up and using a compound light microscope	
<b>C</b> Undertake aseptic techniques to culture microorganisms	<b>C1</b> Safety and prevention of contamination in microbial culturing <b>C2</b> Growth media <b>C3</b> Inoculation and incubation	<p>Laboratory notebooks recording the practical work done plus observations of practical work by suitably qualified staff. Any parts not covered in practical work can be addressed by research reports.</p>
<b>D</b> Explore factors controlling microbial growth in industrial, medical and domestic applications	<b>D1</b> Growth requirements <b>D2</b> Growth inhibitors <b>D3</b> Measuring microbial growth	

## Content

### Learning aim A: Understand the importance of microbial classification to medicine and industry

#### A1 Microorganisms and infectious agents

Similarities and differences in relative sizes, structural features and means of reproduction/replication in the following (both non-pathogenic and pathogenic examples should be examined):

- bacteria (prokaryotes)
- fungi, including yeasts (eukaryotes)
- protozoa
- viruses
- viroids
- prions.

#### A2 Classification

- Characteristics used to classify microorganisms, limited to bacteria, fungi and viruses.
- Bacteria, to include reference to Bergey's Manual of Systematic Biology:
  - Gram staining
  - phenotypic classification, e.g. cocci, bacilli, spirilla
  - oxygen requirements (obligate and facultative aerobes/anaerobes).
- Fungi – Chytridiomycota, Zygomycota, Ascomycota and Basidiomycota.
- Viruses, e.g. size, nucleic acid, capsid structure, host and disease.

#### A3 Microorganisms in medicine and industry

Basic stages involved in classifying and using microorganisms:

- identification of causes of disease
- biowaste processing
- food and beverage production
- nitrogen fixation
- antibiotic and hormone production
- flora and fauna in the human digestive tract.

### Learning aim B: Undertake microscopy for specimen examination in laboratories

#### B1 Microscopes

Basic principles behind different types of microscopes and attachments, including the suitability and preparation of samples for use in each case.

- definitions of resolution, magnification, focus, image
- stereomicroscopes (dissection microscopes)
- compound light microscope, to include the use of oil immersion lenses
- phase contrast, to include uses of special lenses to convert the differences between transmitted and refracted light into variations in intensity
- electron microscope, including transmission and scanning.

**B2 Specimen and slide preparation**

Methods and equipment involved in preparing specimens, including relevant theoretical background, for viewing microorganisms under a compound light microscope. This should include practical application of techniques as appropriate:

- use of flat and concave slides
- cover slips
- wet and dry mounts
- air drying and heat fixing
- smear slides
- staining, e.g. methylene blue, Indian ink, Gram staining.

**B3 Setting up and using a compound light microscope**

- Component parts of the light microscope and their functions:
  - eyepiece and eyepiece graticules
  - coarse and fine adjustment knobs
  - stage
  - mirror and/or light source
  - condenser and adjustment knob
  - iris diaphragm.
- Using the microscope and correct procedures to follow:
  - preparation of microscope to use with a slide
  - adjustment of condenser
  - use of lowest power lens
  - use of other lens magnifications
  - calculation of actual size from scientific drawing of specimens.

**Learning aim C: Undertake aseptic techniques to culture microorganisms****C1 Safety and prevention of contamination in microbial culturing**

- Reasons for and practices in sector-specific safety equipment and procedures in laboratories where microbial investigation takes place.
- Awareness of the meaning of classifications of biosafety in levels 1-4.
- Personal protective equipment (PPE), e.g. nitrile gloves, eye protection, lab coat.
- Safety procedures to follow in a biosafety Level 1 microbiology practical:
  - attention to personal hygiene, hand washing
  - equipment sterilisation
  - mechanical pipetting
  - inoculation of plates
  - culture and examination of plates
  - safe disposal of materials, e.g. autoclaving.
- Biosafety cabinets:
  - negative/positive pressure
  - stainless steel construction
  - class I, II and III.

**C2 Growth media**

- Aseptic techniques and equipment required for preparation of growth media. Learners should prepare growth media where possible.
- Nutrient broths.
- Nutrient agar plates.
- Selective media:
  - MacConkey agar
  - mannitol salt agar
  - blood agar
  - potato dextrose agar.

**C3 Inoculation and incubation**

Role of inoculation and incubation; aseptic techniques and equipment required (the practical application of these techniques by learners is expected):

- inoculation of liquid and solid media, to include streaking and lawn spreads
- importance of incubation temperature, e.g. why incubation at 37 °C is not recommended in school/college laboratories
- use of tape strips to anchor but not seal petri dishes, inversion of dishes during incubation
- length of incubation.

**Learning aim D: Explore factors controlling microbial growth in industrial, medical and domestic applications****D1 Growth requirements**

Factors affecting growth of bacteria and fungi, including relevance to industrial, medical and domestic settings:

- nutrients
- light and temperature preferences.
- oxygen requirements
- pH levels
- growth surfaces.

**D2 Growth inhibitors**

Methods of inhibiting microbial growth in industrial, medical and domestic settings. (Where appropriate, these should be practically investigated by learners.)

- Irradiation.
- Antimicrobials – antibiotics, antivirals.
- Antifungals.
- Disinfectants, e.g. household and industrial cleaning products, hand sanitisers.
- Sterilisation procedures.
- Osmotic potentials in strong salt/sugar solutions as preservatives.
- Controlled atmospheres for food preparation.

**D3 Measuring microbial growth**

Theoretical background and practical application of growth monitoring techniques, to include the interpretation of resulting data:

- colorimetry for fungal, bacterial and viral growth showing turbidity
- haemocytometer, such as in yeast cell counts
- mycelial discs measured as increase in diameter or dry mass
- counting bacterial colonies and use of serial dilution.

## Assessment criteria

Pass	Merit	Distinction
<b>Learning aim A: Understand the importance of microbial classification to medicine and industry</b>		<b>AB.D1</b> Evaluate the use of microscopy techniques to observe structures and classify microorganisms.
<b>A.P1</b> Explain how the structures and characteristics of microorganisms are used to classify them.	<b>A.M1</b> Compare the characteristics of microorganisms used for classification.	
<b>Learning aim B: Undertake microscopy for specimen examination in laboratories</b>		
<b>B.P2</b> Correctly set up and use a light microscope and oil immersion lens to observe structures of microorganisms under magnification. <b>B.P3</b> Illustrate, with accuracy, the structures of microorganisms observed using a light microscope and an oil immersion lens.	<b>B.M2</b> Compare the use of different microscopy techniques to observe the structures of microorganisms.	
<b>Learning aim C: Undertake aseptic techniques to culture microorganisms</b>		<b>CD.D2</b> Evaluate own aseptic techniques used to culture microorganisms with specific reference to the type of media, methods of inoculation chosen and the biocontainment procedures carried out.
<b>C.P4</b> Correctly prepare and inoculate growth media and measure microbial growth using aseptic techniques. <b>C.P5</b> Explain biocontainment procedures in your centre laboratory and within industrial laboratories.	<b>C.M3</b> Demonstrate skilful application of aseptic techniques in inoculation and preparation of growth media and in measuring microbial growth. <b>C.M4</b> Compare biocontainment procedures in your centre laboratory to those used in industrial laboratories.	
<b>Learning aim D: Explore factors controlling microbial growth in industrial, medical and domestic applications</b>		
<b>D.P6</b> Carry out investigations into the effect of growth requirements on microorganisms. <b>D.P7</b> Explain how growth inhibitors affect microorganisms.	<b>D.M5</b> Analyse how growth of microorganisms is affected by changing environmental factors.	

## Essential information for assignments

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

There is a maximum number of two summative assignments for this unit. The relationship of the learning aims and criteria is:

Learning aims: A and B (A.P1, B.P2, B.P3, A.M1, B.M2, AB.D1)

Learning aims: C and D (C.P4, C.P5, D.P6, D.P7, C.M3, C.M4, D.M5, CD.D2)

## Further information for teachers and assessors

### Resource requirements

For this unit, learners must have access to:

- a well-equipped laboratory
- materials/apparatus/equipment and/or laboratory instruments/sensors
- computers, DVDs and suitable texts, appropriate science and maths software packages (especially when working with the results of growth data, which may involve the use of graphs).

It is expected that where possible, appropriate investigative work will be carried out in this unit. Health and safety, and ethical considerations are paramount, and teachers must ensure that the necessary risk assessments are carried out and communicated to their learners. Refer to CLEAPSS and/or your centre's health and safety regulations if in doubt about any of the investigative work that has been suggested.

### Essential information for assessment decisions

#### Learning aims A and B

**For distinction standard,** learners will look at the structures that can be seen under different microscopes and evaluate the advantages and limitations in their use for medicine and industry. They will use their observations and knowledge of the characteristics of microorganisms to argue/reason for their placement in different groups and then evaluate the reasons for such a division. Their work will be detailed and comprehensive, using named examples of at least four of the microorganisms and infectious agents as part of the evaluation process.

**For merit standard,** learners will show they understand the reasons for the classification of microorganisms, comparing the similarities and differences in size, structure, reproduction and their importance in medicine and industry. They will refer to how the structure of microorganisms is viewed using two types of microscope, including their own drawings of specimens viewed under a compound light microscope. They will compare photomicrographs of microorganisms taken using two types of microscopes, showing they understand the differences and similarities between them in terms of their characteristics and how these factors are used to put them into groups before commenting on their importance.

**For pass standard,** learners will use the microscope and an oil immersion lens to look at microorganisms, following instructions to set up and use a light microscope correctly. Learners will produce accurately drawn and labelled diagrams of specimens they have viewed themselves, which will include the magnification used and a calculation of the actual size of objects they have drawn. Learners will use photomicrographs and annotated diagrams to describe the structures observed. They will use named examples where appropriate, and they can include other features providing they state under what circumstances they can be seen, i.e. oil immersion or electron microscope. Learners must use their own drawings in addition to published photomicrographs and other sources of information to explain how microorganisms are classified, making reference to four microorganisms from the unit content.

#### Learning aims C and D

**For distinction standard,** learners will evaluate the impact of the use of the correct media and inoculation techniques on the successful growth of microbes, using their evaluation of practical work plus any research. They will also evaluate their own techniques in comparison with other learners and suggest areas for improvement. They will explain the biocontainment measures taken in the classroom that contributed to the successful growth of the microbes, as well as the importance of biocontainment procedures used in industry and the impact of this when not followed. Learners will list the factors that affect growth in microorganisms, evaluating how

effective their methods were in being able to analyse the effects on growth of changing environmental factors and suggesting suitable alternatives or extensions to the methods or equipment that would enhance their results.

**For merit standard,** learners will work in an efficient way with minimal guidance, demonstrating good aseptic technique that leads to little or no contamination of results. They will measure the resultant microbial growth with precision, leading to a coherent analysis of the results from which sensible conclusions can be drawn. Learners will refer to secondary data to support their analyses. Learners will discuss their experience of the biocontainment measures used in their laboratory in relation to the systems used in industry. They will compare the two settings and explain the reasons for the differences.

**For pass standard,** learners will demonstrate adherence to safety procedures, including the production of suitable risk assessments making it clear that they understand the reasons behind the precautions that must be taken when working with microorganisms. They will follow instructions to obtain results investigating the effect on microbial growth of changing at least one environmental factor. This will include learners preparing and inoculating both liquid and solid media. Learners' measurements will be accurate in terms of taking more than one measurement and averaging the result. They will describe what their results show in terms of microbial growth requirements and growth inhibitors. They will then give an explanation of the biocontainment measures they used for their work, and how these relate to biocontainment procedures in industrial laboratories. Learners may demonstrate isolated elements of knowledge and understanding, with basic but correct use of relevant terminology.

### Links to other units

This unit links to:

- Unit 1: Principles and Applications of Science I
- Unit 2: Practical Scientific Procedures and Techniques
- Unit 8: Physiology of Human Body Systems
- Unit 9: Environmental Forensics
- Unit 13: Forensic Genetics
- Unit 14: Forensic Anthropology and Archaeology

### Employer involvement

It may be possible to arrange a visit to a local facility, hospital or university that has an electron microscope. The local Environmental Health Department may be able to support the centre by providing a visiting Environmental Officer to discuss their role in dealing with the effects of pathogens.

A visit to a microbiology laboratory would be very useful, and a local food-processing factory may be able to offer opportunities for a visit or provide a speaker and additional information.



## 4 Planning your programme

### How do I choose the right BTEC National qualification for my learners?

BTEC Nationals come in a range of sizes, each with a specific purpose. You will need to assess learners very carefully to ensure that they start on the right size of qualification to fit into their 16–19 study programme, and that they take the right pathways or optional units that allow them to progress to the next stage.

Some learners may want to take a number of complementary qualifications or keep their progression options open. These learners may be suited to taking a BTEC National Certificate or Extended Certificate. Learners who then decide to continue with a fuller vocational programme can transfer to a BTEC National Diploma or Extended Diploma, for example for their second year.

Some learners are sure of the sector they want to work in and are aiming for progression into that sector via higher education. These learners should be directed to the two-year BTEC National Extended Diploma as the most suitable qualification.

As a centre, you may want to teach learners who are taking different qualifications together. You may also wish to transfer learners between programmes to meet changes in their progression needs. You should check the qualification structures and unit combinations carefully as there is no exact match among the different sizes. You may find that learners need to complete more than the minimum number of units when transferring.

When learners are recruited, you need to give them accurate information on the title and focus of the qualification for which they are studying.

### Is there a learner entry requirement?

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

Learners are most likely to succeed if they have:

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

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

### What is involved in becoming an approved centre?

All centres must be approved before they can offer these qualifications – so that they are ready to assess learners and so that we can provide the support that is needed. Further information is given in *Section 8*.

### What level of sector knowledge is needed to teach these qualifications?

We do not set any requirements for teachers but recommend that centres assess the overall skills and knowledge of the teaching team to ensure that they are relevant and up to date. This will give learners a rich programme to prepare them for employment in the sector.

### What resources are required to deliver these qualifications?

As part of your centre approval you will need to show that the necessary material resources and work spaces are available to deliver BTEC Nationals. For some units, specific resources are required. This is indicated in the units.

### How can myBTEC help with planning for these qualifications?

myBTEC is an online toolkit that supports the delivery, assessment and quality assurance of BTECs in centres. It supports teachers with activities, such as choosing a valid combination of units, creating assignment briefs and creating assessment plans. For further information see *Section 10*.

### **Which modes of delivery can be used for these qualifications?**

You are free to deliver BTEC Nationals using any form of delivery that meets the needs of your learners. We recommend making use of a wide variety of modes, including direct instruction in classrooms or work environments, investigative and practical work, group and peer work, private study and e-learning.

### **What are the recommendations for employer involvement?**

BTEC Nationals are vocational qualifications and, as an approved centre, you are encouraged to work with employers on the design, delivery and assessment of the course to ensure that learners have a programme of study that is engaging and relevant and that equips them for progression. There are suggestions in many of the units about how employers could become involved in delivery and/or assessment but these are not intended to be exhaustive and there will be other possibilities at local level.

### **What support is available?**

We provide a wealth of support materials, including curriculum plans, delivery guides, authorised assignment briefs, additional papers for external assessments and examples of marked learner work.

You will be allocated a Standards Verifier early on in the planning stage to support you with planning your assessments. There will be extensive training programmes as well as support from our Subject Advisor team.

For further details see *Section 10*.

### **How will my learners become more employable through these qualifications?**

Employability skills, such as team working and entrepreneurialism, and practical hands-on skills have been built into the design of the learning aims and content. This gives you the opportunity to use relevant contexts, scenarios and materials to enable learners to develop a portfolio of evidence that demonstrates the breadth of their skills and knowledge in a way that equips them for employment.

# 5 Assessment structure and external assessment

## Introduction

BTEC Nationals are assessed using a combination of *internal assessments*, which are set and marked by teachers, and *external assessments* which are set and marked by Pearson:

- mandatory units have a combination of internal and external assessments
- all optional units are internally assessed.

We have taken great care to ensure that the assessment method chosen is appropriate to the content of the unit and in line with requirements from employers and higher education.

In developing an overall plan for delivery and assessment for the programme, you will need to consider the order in which you deliver units, whether delivery is over short or long periods and when assessment can take place. Some units are defined as synoptic units (see *Section 2*). Normally, a synoptic assessment is one that a learner would take later in a programme and in which they will be expected to apply learning from a range of units. Synoptic units may be internally or externally assessed. Where a unit is externally assessed you should refer to the sample assessment materials (SAMs) to identify where there is an expectation that learners draw on their wider learning. For internally-assessed units, you must plan the assignments so that learners can demonstrate learning from across their programme. A unit may be synoptic in one qualification and not another because of the relationship it has to the rest of the qualification.

We have addressed the need to ensure that the time allocated to final assessment of internal and external units is reasonable so that there is sufficient time for teaching and learning, formative assessment and development of transferable skills.

In administering internal and external assessment, the centre needs to be aware of the specific procedures and policies that apply, for example to registration, entries and results. An overview with signposting to relevant documents is given in *Section 7*.

## Internal assessment

Our approach to internal assessment for these qualifications will be broadly familiar to experienced centres. It offers flexibility in how and when you assess learners, provided that you meet assessment and quality assurance requirements. You will need to take account of the requirements of the unit format, which we explain in *Section 3*, and the requirements for delivering assessment given in *Section 6*.

## External assessment

A summary of the external assessment for this qualification is given in *Section 2*. You should check this information carefully, together with the unit specification and the sample assessment materials, so that you can timetable learning and assessment periods appropriately.

Learners must be prepared for external assessment by the time they undertake it. In preparing learners for assessment you will want to take account of required learning time, the relationship with other external assessments and opportunities for retaking. You should ensure that learners are not entered for unreasonable amounts of external assessment in one session. Learners may resit an external assessment to obtain a higher grade of near pass or above. If a learner has more than one attempt, then the best result will be used for qualification grading, up to the permitted maximum. It is unlikely that learners will need to or benefit from taking all assessments twice so you are advised to plan appropriately. Some assessments are synoptic and learners are likely to perform best if these assessments are taken towards the end of the programme.

## Key features of external assessment in forensic and criminal investigation

In forensic and criminal investigation, after consultation with stakeholders, we have developed the following.

- *Unit 1: Principles and Applications of Science I* is an exam-based assessment where learners will respond to a range of different question types, including multiple-choice, short-answer and extended open-response questions, as well as calculations. They will demonstrate their knowledge and understanding of key areas of science. This assessment covers the core principles across the three science disciplines. Learners will make judgements and reach conclusions by evaluating scientific information and making connections between different scientific concepts, procedures and processes.
- *Unit 3: Science Investigation Skills* is a task-based assessment where learners will demonstrate their skills in carrying out a scientific practical investigation to collect and record data. The investigation will be from one of the content areas covered in the unit. Learners will be assessed on their interpretation, analysis, planning and evaluation skills by using the data they have collected. They will apply their knowledge and understanding of scientific concepts, processes and procedures to plan an investigation for a different area of content and critique a method and set of results given.
- *Unit 5: Applications of Criminology* is a task-based assessment where learners will demonstrate knowledge and understanding of crime and criminal behaviour. They will draw on theories to explain the causes of crime and punishment/prevention methods for criminal behaviour, based on a pre-released article. The task will focus on how the media influences the portrayal of crime, looking at how the media can shape our perception of crime, as well as determining what may influence the likelihood of an individual being a victim of crime.
- *Unit 7: Applications of Criminal and Forensic Psychology* is a task-based assessment where learners will demonstrate knowledge and understanding of psychological ideas, concepts and approaches through contexts. They will apply understanding of psychological approaches to propose and rationalise a treatment programme that has relevance to the scenario. Learners will create an offender profile and rationalise its importance to the police through analysis and evaluation of psychological information given. Learners will interpret and analyse psychological information to draw links between the scenario, information and different psychological ideas, concepts and approaches.

## Units

The externally-assessed units have a specific format which we explain in *Section 3*. The content of units will be sampled across external assessments over time through appropriate papers and tasks. The ways in which learners are assessed are shown through the assessment outcomes and grading descriptors. External assessments are marked and awarded using the grade descriptors. The grades available are Distinction (D), Merit (M), Pass (P) and Near Pass (N). The Near Pass (N) grade gives learners credit below a Pass, where they have demonstrated evidence of positive performance which is worth more than an unclassified result but not yet at the Pass standard.

## Sample assessment materials

Each externally-assessed unit has a set of sample assessment materials (SAMs) that accompanies this specification. The SAMs are there to give you an example of what the external assessment will look like in terms of the feel and level of demand of the assessment. In the case of units containing synoptic assessment, the SAMs will also show where learners are expected to select and apply from across the programme.

The SAMs show the range of possible question types that may appear in the actual assessments and give you a good indication of how the assessments will be structured. While SAMs can be used for practice with learners, as with any assessment the content covered and specific details of the questions asked will change in each assessment.

A copy of each of these assessments can be downloaded from our website. An additional sample of each of the Pearson-set units will be available before the first sitting of the assessment to allow your learners further opportunities for practice.

## 6 Internal assessment

This section gives an overview of the key features of internal assessment and how you, as an approved centre, can offer it effectively. The full requirements and operational information are given in the *Pearson Quality Assurance Handbook*. All members of the assessment team need to refer to this document.

For BTEC Nationals it is important that you can meet the expectations of stakeholders and the needs of learners by providing a programme that is practical and applied. Centres can tailor programmes to meet local needs and use links with local employers and the wider vocational sector.

When internal assessment is operated effectively it is challenging, engaging, practical and up to date. It must also be fair to all learners and meet national standards.

### Principles of internal assessment

#### Assessment through assignments

For internally-assessed units, the format of assessment is an assignment taken after the content of the unit, or part of the unit if several assignments are used, has been delivered. An assignment may take a variety of forms, including practical and written types. An assignment is a distinct activity completed independently by learners that is separate from teaching, practice, exploration and other activities that learners complete with direction from, and formative assessment by, teachers.

An assignment is issued to learners as an assignment brief with a defined start date, a completion date and clear requirements for the evidence that they need to provide. There may be specific observed practical components during the assignment period. Assignments can be divided into tasks and may require several forms of evidence. A valid assignment will enable a clear and formal assessment outcome based on the assessment criteria.

#### Assessment decisions through applying unit-based criteria

Assessment decisions for BTEC Nationals are based on the specific criteria given in each unit and set at each grade level. To ensure that standards are consistent in the qualification and across the suite as a whole, the criteria for each unit have been defined according to a framework. The way in which individual units are written provides a balance of assessment of understanding, practical skills and vocational attributes appropriate to the purpose of qualifications.

The assessment criteria for a unit are hierarchical and holistic. For example, if an M criterion requires the learner to show 'analysis' and the related P criterion requires the learner to 'explain', then to satisfy the M criterion a learner will need to cover both 'explain' and 'analyse'. The unit assessment grid shows the relationships among the criteria so that assessors can apply all the criteria to the learner's evidence at the same time. In *Appendix 2* we have set out a definition of terms that assessors need to understand.

Assessors must show how they have reached their decisions using the criteria in the assessment records. When a learner has completed all the assessment for a unit then the assessment team will give a grade for the unit. This is given simply according to the highest level for which the learner is judged to have met all the criteria. Therefore:

- to achieve a Distinction, a learner must have satisfied all the Distinction criteria (and therefore the Pass and Merit criteria); these define outstanding performance across the unit as a whole
- to achieve a Merit, a learner must have satisfied all the Merit criteria (and therefore the Pass criteria) through high performance in each learning aim
- to achieve a Pass, a learner must have satisfied all the Pass criteria for the learning aims, showing coverage of the unit content and therefore attainment at Level 3 of the national framework.

The award of a Pass is a defined level of performance and cannot be given solely on the basis of a learner completing assignments. Learners who do not satisfy the Pass criteria should be reported as Unclassified.

## The assessment team

It is important that there is an effective team for internal assessment. There are three key roles involved in implementing assessment processes in your centre, each with different interrelated responsibilities, the roles are listed below. Full information is given in the *Pearson Quality Assurance Handbook*.

- The Lead Internal Verifier (the Lead IV) has overall responsibility for the programme, its assessment and internal verification to meet our requirements, record keeping and liaison with the Standards Verifier. The Lead IV registers with Pearson annually. The Lead IV acts as an assessor, supports the rest of the assessment team, makes sure that they have the information they need about our assessment requirements and organises training, making use of our guidance and support materials.
- Internal Verifiers (IVs) oversee all assessment activity in consultation with the Lead IV. They check that assignments and assessment decisions are valid and that they meet our requirements. IVs will be standardised by working with the Lead IV. Normally, IVs are also assessors but they do not verify their own assessments.
- Assessors set or use assignments to assess learners to national standards. Before taking any assessment decisions, assessors participate in standardisation activities led by the Lead IV. They work with the Lead IV and IVs to ensure that the assessment is planned and carried out in line with our requirements.

## Effective organisation

Internal assessment needs to be well organised so that the progress of learners can be tracked and so that we can monitor that assessment is being carried out in line with national standards. We support you through, for example, providing training materials and sample documentation. Our online myBTEC service can help support you in planning and record keeping. Further information on using myBTEC can be found in *Section 10* and on our website.

It is particularly important that you manage the overall assignment programme and deadlines to make sure that learners are able to complete assignments on time.

## Learner preparation

To ensure that you provide effective assessment for your learners, you need to make sure that they understand their responsibilities for assessment and the centre's arrangements.

From induction onwards, you will want to ensure that learners are motivated to work consistently and independently to achieve the requirements of the qualifications. Learners need to understand how assignments are used, the importance of meeting assignment deadlines, and that all the work submitted for assessment must be their own.

You will need to give learners a guide that explains how assignments are used for assessment, how assignments relate to the teaching programme, and how learners should use and reference source materials, including what would constitute plagiarism. The guide should also set out your approach to operating assessment, such as how learners must submit work and request extensions.

## Setting effective assignments

### Setting the number and structure of assignments

In setting your assignments, you need to work with the structure of assignments shown in the *Essential information for assignments* section of a unit. This shows the structure of the learning aims and criteria that you must follow and the recommended number of assignments that you should use. For some units we provide authorised assignment briefs, for all the units we give you suggestions on how to create suitable assignments. You can find these materials along with this specification on our website. In designing your own assignment briefs you should bear in mind the following points.

- The number of assignments for a unit must not exceed the number shown in *Essential information for assignments*. However, you may choose to combine assignments, for example to create a single assignment for the whole unit.
- You may also choose to combine all or parts of different units into single assignments, provided that all units and all their associated learning aims are fully addressed in the programme overall. If you choose to take this approach, you need to make sure that learners are fully prepared so that they can provide all the required evidence for assessment and that you are able to track achievement in the records.
- A learning aim must always be assessed as a whole and must not be split into two or more tasks.
- The assignment must be targeted to the learning aims but the learning aims and their associated criteria are not tasks in themselves. Criteria are expressed in terms of the outcome shown in the evidence.
- You do not have to follow the order of the learning aims of a unit in setting assignments but later learning aims often require learners to apply the content of earlier learning aims and they may require learners to draw their learning together.
- Assignments must be structured to allow learners to demonstrate the full range of achievement at all grade levels. Learners need to be treated fairly by being given the opportunity to achieve a higher grade if they have the ability.
- As assignments provide a final assessment, they will draw on the specified range of teaching content for the learning aims. The specified content is compulsory. The evidence for assessment need not cover every aspect of the teaching content as learners will normally be given particular examples, case studies or contexts in their assignments. For example, if a learner is carrying out one practical performance, or an investigation of one organisation, then they will address all the relevant range of content that applies in that instance.

### Providing an assignment brief

A good assignment brief is one that, through providing challenging and realistic tasks, motivates learners to provide appropriate evidence of what they have learned.

An assignment brief should have:

- a vocational scenario, this could be a simple situation or a full, detailed set of vocational requirements that motivates the learner to apply their learning through the assignment
- clear instructions to the learner about what they are required to do, normally set out through a series of tasks
- an audience or purpose for which the evidence is being provided
- an explanation of how the assignment relates to the unit(s) being assessed.

## Forms of evidence

BTEC Nationals have always allowed for a variety of forms of evidence to be used, provided that they are suited to the type of learning aim being assessed. For many units, the practical demonstration of skills is necessary and for others, learners will need to carry out their own research and analysis. The units give you information on what would be suitable forms of evidence to provide learners with the opportunity to apply a range of employability or transferable skills. Centres may choose to use different suitable forms for evidence to those proposed. Overall, learners should be assessed using varied forms of evidence.

Full definitions of types of assessment are given in *Appendix 2*. These are some of the main types of assessment:

- written reports
- projects
- time-constrained practical assessments with observation records and supporting evidence
- recordings of performance
- sketchbooks, working logbooks, reflective journals
- presentations with assessor questioning.

The form(s) of evidence selected must:

- allow the learner to provide all the evidence required for the learning aim(s) and the associated assessment criteria at all grade levels
- allow the learner to produce evidence that is their own independent work
- allow a verifier to independently reassess the learner to check the assessor's decisions.

For example, when you are using performance evidence, you need to think about how supporting evidence can be captured through recordings, photographs or task sheets.

Centres need to take particular care that learners are enabled to produce independent work. For example, if learners are asked to use real examples, then best practice would be to encourage them to use their own or to give the group a number of examples that can be used in varied combinations.

## Making valid assessment decisions

### Authenticity of learner work

Once an assessment has begun, learners must not be given feedback on progress towards fulfilling the targeted criteria.

An assessor must assess only learner work that is authentic, i.e. learners' own independent work. Learners must authenticate the evidence that they provide for assessment through signing a declaration stating that it is their own work.

Assessors must ensure that evidence is authentic to a learner through setting valid assignments and supervising them during the assessment period. Assessors must take care not to provide direct input, instructions or specific feedback that may compromise authenticity.

Assessors must complete a declaration that:

- the evidence submitted for this assignment is the learner's own
- the learner has clearly referenced any sources used in the work
- they understand that false declaration is a form of malpractice.

Centres can use Pearson templates or their own templates to document authentication.

During assessment, an assessor may suspect that some or all of the evidence from a learner is not authentic. The assessor must then take appropriate action using the centre's policies for malpractice. Further information is given in *Section 7*.

### Making assessment decisions using criteria

Assessors make judgements using the criteria. The evidence from a learner can be judged using all the relevant criteria at the same time. The assessor needs to make a judgement against each criterion that evidence is present and sufficiently comprehensive. For example, the inclusion of a concluding section may be insufficient to satisfy a criterion requiring 'evaluation'.

Assessors should use the following information and support in reaching assessment decisions:

- the *Essential information for assessment decisions* section in each unit gives examples and definitions related to terms used in the criteria
- the explanation of key terms in *Appendix 2*
- examples of assessed work provided by Pearson
- your Lead IV and assessment team's collective experience, supported by the standardisation materials we provide.

Pass and Merit criteria relate to individual learning aims. The Distinction criteria as a whole relate to outstanding performance across the unit. Therefore, criteria may relate to more than one learning aim (for example A.D1) or to several learning aims (for example DE.D3). Distinction criteria make sure that learners have shown that they can perform consistently at an outstanding level across the unit and/or that they are able to draw learning together across learning aims.

### Dealing with late completion of assignments

Learners must have a clear understanding of the centre policy on completing assignments by the deadlines that you give them. Learners may be given authorised extensions for legitimate reasons, such as illness at the time of submission, in line with your centre policies.

For assessment to be fair, it is important that learners are all assessed in the same way and that some learners are not advantaged by having additional time or the opportunity to learn from others. Therefore, learners who do not complete assignments by your planned deadline or the authorised extension deadline may not have the opportunity to subsequently resubmit.

If you accept a late completion by a learner, then the assignment should be assessed normally when it is submitted using the relevant assessment criteria.

## Issuing assessment decisions and feedback

Once the assessment team has completed the assessment process for an assignment, the outcome is a formal assessment decision. This is recorded formally and reported to learners.

The information given to the learner:

- must show the formal decision and how it has been reached, indicating how or where criteria have been met
- may show why attainment against criteria has not been demonstrated
- must not provide feedback on how to improve evidence
- must be validated by an IV before it is given to the learner.

## Resubmission of improved evidence

An assignment provides the final assessment for the relevant learning aims and is normally a final assessment decision, except where the Lead IV approves one opportunity to resubmit improved evidence based on the completed assignment brief.

The Lead IV has the responsibility to make sure that resubmission is operated fairly. This means:

- checking that a learner can be reasonably expected to perform better through a second submission, for example that the learner has not performed as expected
- making sure that giving a further opportunity can be done in such a way that it does not give an unfair advantage over other learners, for example through the opportunity to take account of feedback given to other learners
- checking that the assessor considers that the learner will be able to provide improved evidence without further guidance and that the original evidence submitted remains valid.

Once an assessment decision has been given to the learner, the resubmission opportunity must have a deadline within 15 working days in the same academic year.

A resubmission opportunity must not be provided where learners:

- have not completed the assignment by the deadline without the centre's agreement
- have submitted work that is not authentic.

## Retake of internal assessment

A learner who has not achieved the level of performance required to pass the relevant learning aims after resubmission of an assignment may be offered a single retake opportunity using a new assignment. The retake may only be achieved at a pass.

The Lead Internal Verifier must only authorise a retake of an assignment in exceptional circumstances where they believe it is necessary, appropriate and fair to do so. For further information on offering a retake opportunity, you should refer to the *BTEC Centre Guide to Internal Assessment*. We provide information on writing assignments for retakes on our website ([www.btec.co.uk/keydocuments](http://www.btec.co.uk/keydocuments)).

## Planning and record keeping

For internal processes to be effective, an assessment team needs to be well organised and keep effective records. The centre will also work closely with us so that we can quality assure that national standards are being satisfied. This process gives stakeholders confidence in the assessment approach.

The Lead IV must have an assessment plan, produced as a spreadsheet or using myBTEC. When producing a plan, the assessment team may wish to consider:

- the time required for training and standardisation of the assessment team
- the time available to undertake teaching and carry out assessment, taking account of when learners may complete external assessments and when quality assurance will take place
- the completion dates for different assignments
- who is acting as IV for each assignment and the date by which the assignment needs to be verified
- setting an approach to sampling assessor decisions through internal verification that covers all assignments, assessors and a range of learners
- how to manage the assessment and verification of learners' work so that they can be given formal decisions promptly
- how resubmission opportunities can be scheduled.

The Lead IV will also maintain records of assessment undertaken. The key records are:

- verification of assignment briefs
- learner authentication declarations
- assessor decisions on assignments, with feedback given to learners
- verification of assessment decisions.

Examples of records and further information are given in the *Pearson Quality Assurance Handbook*.

# 7 Administrative arrangements

## Introduction

This section focuses on the administrative requirements for delivering a BTEC qualification. It will be of value to Quality Nominees, Lead IVs, Programme Leaders and Examinations Officers.

## Learner registration and entry

Shortly after learners start the programme of learning, you need to make sure that they are registered for the qualification and that appropriate arrangements are made for internal and external assessment. You need to refer to the *Information Manual* for information on making registrations for the qualification and entries for external assessments.

Learners can be formally assessed only for a qualification on which they are registered. If learners' intended qualifications change, for example if a learner decides to choose a different pathway specialism, then the centre must transfer the learner appropriately.

## Access to assessment

Both internal and external assessments need to be administered carefully to ensure that all learners are treated fairly, and that results and certification are issued on time to allow learners to progress to chosen progression opportunities.

Our equality policy requires that all learners should have equal opportunity to access our qualifications and assessments, and that our qualifications are awarded in a way that is fair to every learner. We are committed to making sure that:

- learners with a protected characteristic are not, when they are undertaking one of our qualifications, disadvantaged in comparison to learners who do not share that characteristic
- all learners achieve the recognition they deserve for undertaking a qualification and that this achievement can be compared fairly to the achievement of their peers.

Further information on access arrangements can be found in the Joint Council for Qualifications (JCQ) document *Access Arrangements, Reasonable Adjustments and Special Consideration for General and Vocational Qualifications*.

## Administrative arrangements for internal assessment

### Records

You are required to retain records of assessment for each learner. Records should include assessments taken, decisions reached and any adjustments or appeals. Further information can be found in the *Information Manual*. We may ask to audit your records so they must be retained as specified.

### Reasonable adjustments to assessment

A reasonable adjustment is one that is made before a learner takes an assessment to ensure that they have fair access to demonstrate the requirements of the assessments. You are able to make adjustments to internal assessments to take account of the needs of individual learners. In most cases this can be achieved through a defined time extension or by adjusting the format of evidence. We can advise you if you are uncertain as to whether an adjustment is fair and reasonable. You need to plan for time to make adjustments if necessary.

Further details on how to make adjustments for learners with protected characteristics are given on our website in the document *Supplementary guidance for reasonable adjustment and special consideration in vocational internally-assessed units*.

### Special consideration

Special consideration is given after an assessment has taken place for learners who have been affected by adverse circumstances, such as illness. You must operate special consideration in line with our policy (see previous paragraph). You can provide special consideration related to the period of time given for evidence to be provided or for the format of the assessment if it is equally valid. You may not substitute alternative forms of evidence to that required in a unit, or omit the application of any assessment criteria to judge attainment. Pearson can consider applications for special consideration in line with the policy.

### Appeals against assessment

Your centre must have a policy for dealing with appeals from learners. These appeals may relate to assessment decisions being incorrect or assessment not being conducted fairly. The first step in such a policy could be a consideration of the evidence by a Lead IV or other member of the programme team. The assessment plan should allow time for potential appeals after assessment decisions have been given to learners. If there is an appeal by a learner, you must document the appeal and its resolution. Learners have a final right of appeal to Pearson but only if the procedures that you have put in place have not been followed. Further details are given in the document *Enquiries and appeals about Pearson vocational qualifications and end point assessment policy*.

## Administrative arrangements for external assessment

### Entries and resits

For information on the timing of assessment and entries, please refer to the annual examinations timetable on our website.

### Access arrangements requests

Access arrangements are agreed with Pearson before an assessment. They allow students with special educational needs, disabilities or temporary injuries to:

- access the assessment
- show what they know and can do without changing the demands of the assessment.

Access arrangements should always be processed at the time of registration. Learners will then know what type of arrangements are available in place for them.

### Granting reasonable adjustments

For external assessment, a reasonable adjustment is one that we agree to make for an individual learner. A reasonable adjustment is defined for the individual learner and informed by the list of available access arrangements.

Whether an adjustment will be considered reasonable will depend on a number of factors, to include:

- the needs of the learner with the disability
- the effectiveness of the adjustment
- the cost of the adjustment; and
- the likely impact of the adjustment on the learner with the disability and other learners.

Adjustment may be judged unreasonable and not approved if it involves unreasonable costs, timeframes or affects the integrity of the assessment.

### Special consideration requests

Special consideration is an adjustment made to a student's mark or grade after an external assessment to reflect temporary injury, illness or other indisposition at the time of the assessment. An adjustment is made only if the impact on the learner is such that it is reasonably likely to have had a material effect on that learner being able to demonstrate attainment in the assessment.

Centres are required to notify us promptly of any learners who they believe have been adversely affected and request that we give special consideration. Further information can be found in the special requirements section on our website.

## Conducting external assessments

Centres must make arrangements for the secure delivery of external assessments. External assessments for BTEC qualifications include examinations, set tasks and performance.

Each external assessment has a defined degree of control under which it must take place. Some external assessments may have more than one part and each part may have a different degree of control. We define degrees of control as follows.

### High control

This is the completion of assessment in formal invigilated examination conditions.

### Medium control

This is completion of assessment, usually over a longer period of time, which may include a period of controlled conditions. The controlled conditions may allow learners to access resources, prepared notes or the internet to help them complete the task.

### Low control

These are activities completed without direct supervision. They may include research, preparation of materials and practice. The materials produced by learners under low control will not be directly assessed.

Further information on responsibilities for conducting external assessment is given in the document *Instructions for Conducting External Assessments*, available on our website.

## Dealing with malpractice in assessment

Malpractice means acts that undermine the integrity and validity of assessment, the certification of qualifications, and/or that may damage the authority of those responsible for delivering the assessment and certification.

Pearson does not tolerate actions (or attempted actions) of malpractice by learners, centre staff or centres in connection with Pearson qualifications. Pearson may impose penalties and/or sanctions on learners, centre staff or centres where incidents (or attempted incidents) of malpractice have been proven.

Malpractice may arise or be suspected in relation to any unit or type of assessment within the qualification. For further details regarding malpractice and advice on preventing malpractice by learners, please see Pearson's *Centre guidance: Dealing with malpractice and maladministration in vocational qualifications*, available on our website.

The procedures we ask you to adopt vary between units that are internally-assessed and those that are externally assessed.

### Internally-assessed units

Centres are required to take steps to prevent malpractice and to investigate instances of suspected malpractice. Learners must be given information that explains what malpractice is for internal assessment and how suspected incidents will be dealt with by the centre. The *Centre Guidance: Dealing with Malpractice* document gives full information on the actions we expect you to take.

Pearson may conduct investigations if we believe that a centre is failing to conduct internal assessment according to our policies. The above document gives further information, examples and details the penalties and sanctions that may be imposed.

In the interests of learners and centre staff, centres need to respond effectively and openly to all requests relating to an investigation into an incident of suspected malpractice.

### Externally-assessed units

External assessment means all aspects of units that are designated as external in this specification, including preparation for tasks and performance. For these assessments, centres must follow the JCQ procedures set out in the latest version of *JCQ Suspected Malpractice in Examinations and Assessments Policies and Procedures* ([www.jcq.org.uk](http://www.jcq.org.uk)).

In the interests of learners and centre staff, centres need to respond effectively and openly to all requests relating to an investigation into an incident of suspected malpractice.

### Learner malpractice

Heads of Centres are required to report incidents of any suspected learner malpractice that occur during Pearson external assessments. We ask that centres do so by completing a *JCQ Form M1* (available at [www.jcq.org.uk/exams-office/malpractice](http://www.jcq.org.uk/exams-office/malpractice)) and emailing it and any accompanying documents (signed statements from the learner, invigilator, copies of evidence, etc.) to the Investigations Team at [candidatemalpractice@pearson.com](mailto:candidatemalpractice@pearson.com). The responsibility for determining appropriate sanctions or penalties to be imposed on learners lies with Pearson.

Learners must be informed at the earliest opportunity of the specific allegation and the centre's malpractice policy, including the right of appeal. Learners found guilty of malpractice may be disqualified from the qualification for which they have been entered with Pearson.

## Teacher/centre malpractice

Heads of Centres are required to inform Pearson's Investigations Team of any incident of suspected malpractice by centre staff, before any investigation is undertaken. Heads of centres are requested to inform the Investigations Team by submitting a *JCQ Form M2(a)* (available at [www.jcq.org.uk/exams-office/malpractice](http://www.jcq.org.uk/exams-office/malpractice)) with supporting documentation to [pqsmalpractice@pearson.com](mailto:pqsmalpractice@pearson.com). Where Pearson receives allegations of malpractice from other sources (for example Pearson staff or anonymous informants), the Investigations Team will conduct the investigation directly or may ask the head of centre to assist.

Incidents of maladministration (accidental errors in the delivery of Pearson qualifications that may affect the assessment of learners) should also be reported to the Investigations Team using the same method.

Heads of Centres/Principals/Chief Executive Officers or their nominees are required to inform learners and centre staff suspected of malpractice of their responsibilities and rights; see Section 6.15 of the *JCQ Suspected Malpractice in Examinations and Assessments Policies and Procedures* document.

Pearson reserves the right in cases of suspected malpractice to withhold the issuing of results and/or certificates while an investigation is in progress. Depending on the outcome of the investigation results and/or certificates may be released or withheld.

You should be aware that Pearson may need to suspend certification when undertaking investigations, audits and quality assurances processes. You will be notified within a reasonable period of time if this occurs.

## Sanctions and appeals

Where malpractice is proven we may impose sanctions or penalties.

Where learner malpractice is evidenced, penalties may be imposed such as:

- mark reduction for external assessments
- disqualification from the qualification
- being barred from registration for Pearson qualifications for a period of time.

If we are concerned about your centre's quality procedures we may impose sanctions such as:

- working with you to create an improvement action plan
- requiring staff members to receive further training
- placing temporary blocks on your certificates
- placing temporary blocks on registration of learners
- debarring staff members or the centre from delivering Pearson qualifications
- suspending or withdrawing centre approval status.

The centre will be notified if any of these apply.

Pearson has established procedures for centres that are considering appeals against penalties and sanctions arising from malpractice. Appeals against a decision made by Pearson will normally be accepted only from Heads of Centres (on behalf of learners and/or members of staff) and from individual members (in respect of a decision taken against them personally). Further information on appeals can be found in our *Enquiries and appeals about Pearson vocational qualifications and end point assessment policy*, which is on our website. In the initial stage of any aspect of malpractice, please notify the Investigations Team by email via [pqsmalpractice@pearson.com](mailto:pqsmalpractice@pearson.com) who will inform you of the next steps.

## Certification and results

Once a learner has completed all the required components for a qualification, even if final results for external assessments have not been issued, then the centre can claim certification for the learner, provided that quality assurance has been successfully completed. For the relevant procedures please refer to our *Information Manual*. You can use the information provided on qualification grading to check overall qualification grades.

### Results issue

After the external assessment session, learner results will be issued to centres. The result will be in the form of a grade. You should be prepared to discuss performance with learners, making use of the information we provide and post-results services.

### Post-assessment services

Once results for external assessments are issued, you may find that the learner has failed to achieve the qualification or to attain an anticipated grade. It is possible to transfer or reopen registration in some circumstances. The *Information Manual* gives further information.

### Changes to qualification requests

Where a learner who has taken a qualification wants to resit an externally-assessed unit to improve their qualification grade, you firstly need to decline their overall qualification grade. You may decline the grade before the certificate is issued. For a learner receiving their results in August, you should decline the grade by the end of September if the learner intends to resit an external assessment.

## Additional documents to support centre administration

As an approved centre you must ensure that all staff delivering, assessing and administering the qualifications have access to this documentation. These documents are reviewed annually and are reissued if updates are required.

- *Pearson Quality Assurance Handbook*: this sets out how we will carry out quality assurance of standards and how you need to work with us to achieve successful outcomes.
- *Information Manual*: this gives procedures for registering learners for qualifications, transferring registrations, entering for external assessments and claiming certificates.
- *Lead Examiners' Reports*: these are produced after each series for each external assessment and give feedback on the overall performance of learners in response to tasks or questions set.
- *Instructions for the Conduct of External Assessments (ICEA)*: this explains our requirements for the effective administration of external assessments, such as invigilation and submission of materials.
- *Regulatory policies*: our regulatory policies are integral to our approach and explain how we meet internal and regulatory requirements. We review the regulated policies annually to ensure that they remain fit for purpose. Policies related to this qualification include:
  - adjustments for candidates with disabilities and learning difficulties, access arrangements and reasonable adjustments for general and vocational qualifications
  - age of learners
  - centre guidance for dealing with malpractice
  - recognition of prior learning and process.

This list is not exhaustive and a full list of our regulatory policies can be found on our website.

## 8 Quality assurance

### Centre and qualification approval

As part of the approval process, your centre must make sure that the resource requirements listed below are in place before offering the qualification.

- Centres must have appropriate physical resources (for example, equipment, IT, learning materials, teaching rooms) to support the delivery and assessment of the qualification.
- Staff involved in the assessment process must have relevant expertise and/or occupational experience.
- There must be systems in place to ensure continuing professional development for staff delivering the qualification.
- Centres must have in place appropriate health and safety policies relating to the use of equipment by learners.
- Centres must deliver the qualification in accordance with current equality legislation.
- Centres should refer to the teacher guidance section in individual units to check for any specific resources required.

### Continuing quality assurance and standards verification

On an annual basis, we produce the *Pearson Quality Assurance Handbook*. It contains detailed guidance on the quality processes required to underpin robust assessment and internal verification.

The key principles of quality assurance are that:

- a centre delivering BTEC programmes must be an approved centre, and must have approval for the programmes or groups of programmes that it is delivering
- the centre agrees, as part of gaining approval, to abide by specific terms and conditions around the effective delivery and quality assurance of assessment; it must abide by these conditions throughout the period of delivery
- Pearson makes available to approved centres a range of materials and opportunities, through online standardisation, intended to exemplify the processes required for effective assessment, and examples of effective standards. Approved centres must use the materials and services to ensure that all staff delivering BTEC qualifications keep up to date with the guidance on assessment
- an approved centre must follow agreed protocols for standardisation of assessors and verifiers, for the planning, monitoring and recording of assessment processes, and for dealing with special circumstances, appeals and malpractice.

The approach of quality-assured assessment is through a partnership between an approved centre and Pearson. We will make sure that each centre follows best practice and employs appropriate technology to support quality-assurance processes, where practicable. We work to support centres and seek to make sure that our quality-assurance processes do not place undue bureaucratic processes on centres. We monitor and support centres in the effective operation of assessment and quality assurance.

The methods we use to do this for BTEC Level 3 include:

- making sure that all centres complete appropriate declarations at the time of approval
- undertaking approval visits to centres
- making sure that centres have effective teams of assessors and verifiers who are trained to undertake assessment
- assessment sampling and verification, through requested samples of assessments, completed assessed learner work and associated documentation
- an overarching review and assessment of a centre's strategy for delivering and quality assuring its BTEC programmes, for example making sure that synoptic units are placed appropriately in the order of delivery of the programme.

Centres that do not fully address and maintain rigorous approaches to delivering, assessing and quality assurance cannot seek certification for individual programmes or for all BTEC Level 3 programmes. An approved centre must make certification claims only when authorised by us and strictly in accordance with requirements for reporting.

Centres that do not comply with remedial action plans may have their approval to deliver qualifications removed.

## 9 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 learner. It shows how all the qualifications in this sector are graded. The awarding and certification of these qualifications will comply with regulatory requirements.

### Eligibility for an award

In order to be awarded a qualification, a learner must complete all units, achieve a Near Pass (N) or above in all external units and a pass or above in all mandatory units unless otherwise specified. Refer to the structure in *Section 2*.

To achieve any qualification grade, learners must:

- complete and **have an outcome** (D, M, P, N or U) for all units within a valid combination
- achieve the **required units at Pass or above** shown in *Section 2*, and for the Extended Diploma achieve a minimum 900 GLH at Pass or above (or N or above in external units)
- 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. Learners who do not achieve the required minimum grade (N or P) in units shown in the structure will not achieve a qualification.

Learners 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.

### Calculation of the qualification grade

The final grade awarded for a qualification represents an aggregation of a learner'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.

In the event that a learner achieves more than the required number of optional units, the mandatory units along with the optional units with the highest grades will be used to calculate the overall result, subject to the eligibility requirements for that particular qualification title.

BTEC Nationals are Level 3 qualifications and 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 qualification grade* table, shown further on in this section, shows the minimum thresholds for calculating these grades. The table will be kept under review over the lifetime of the qualification. The most up to date table will be issued on our website.

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

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

### Points available for internal units

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

	Unit size	
	60 GLH	90 GLH
U	0	0
Pass	6	9
Merit	10	15
Distinction	16	24

### Points available for external units

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

	Unit size	
	90 GLH	120 GLH
U	0	0
Near Pass	6	8
Pass	9	12
Merit	15	20
Distinction	24	32

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

### Claiming the qualification grade

Subject to eligibility, Pearson will automatically calculate the qualification grade for your learners when the internal unit grades are submitted and the qualification claim is made. Learners will be awarded qualification grades for achieving the sufficient number of points within the ranges shown in the relevant *Calculation of qualification grade* table for the cohort.

## Calculation of qualification grade

Applicable for registration from 1 September 2018.

Foundation Diploma		Diploma		Extended Diploma	
510 GLH		720 GLH		1080 GLH	
Grade	Points threshold	Grade	Points threshold	Grade	Points threshold
U	0	U	0	U	0
Pass	51	PP	72	PPP	108
		MP	88	MPP	124
				MMP	140
Merit	73	MM	104	MMM	156
		DM	124	DMM	176
				DDM	196
Distinction	104	DD	144	DDD	216
		D*D	162	D*DD	234
				D*D*D	252
Distinction*	130	D*D*	180	D*D*D*	270

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

## Examples of grade calculations based on table applicable to registrations from September 2018

### Example 1: Achievement of an Extended Diploma with a PPP grade

	GLH	Type (Int/Ext)	Grade	Unit points
Unit 1	90	Ext	Pass	9
Unit 2	90	Int	Pass	9
Unit 3	120	Ext	Pass	12
Unit 4	90	Int	Merit	15
Unit 5	120	Ext	Pass	12
Unit 6	90	Int	Pass	9
Unit 7	120	Ext	Merit	20
Unit 8	60	Int	U	0
Unit 9	60	Int	Pass	6
Unit 10	60	Int	Merit	10
Unit 11	60	Int	Pass	6
Unit 12	60	Int	Pass	6
Unit 13	60	Int	Pass	6
<b>Totals</b>	<b>1080</b>		<b>PPP</b>	<b>120</b>

The learner has achieved N or higher in Units 1, 3, 5 and 7 and P or higher in Units 2, 4 and 6.

The learner has sufficient points for a PPP grade.

### Example 2: Achievement of an Extended Diploma with a DDD grade

	GLH	Type (Int/Ext)	Grade	Unit points
Unit 1	90	Ext	Near Pass	6
Unit 2	90	Int	Pass	9
Unit 3	120	Ext	Distinction	32
Unit 4	90	Int	Merit	15
Unit 5	120	Ext	Distinction	32
Unit 6	90	Int	Distinction	24
Unit 7	120	Ext	Merit	20
Unit 8	60	Int	Distinction	16
Unit 9	60	Int	Distinction	16
Unit 10	60	Int	Merit	10
Unit 11	60	Int	Merit	10
Unit 12	60	Int	Distinction	16
Unit 13	60	Int	Merit	10
<b>Totals</b>	<b>1080</b>		<b>DDD</b>	<b>216</b>

The learner has sufficient points for a DDD grade.

### Example 3: An Unclassified result for an Extended Diploma

	GLH	Type (Int/Ext)	Grade	Unit points
Unit 1	90	Ext	Pass	9
Unit 2	90	Int	Merit	15
Unit 3	120	Ext	Pass	12
Unit 4	90	Int	Merit	15
Unit 5	120	Ext	Pass	12
Unit 6	90	Int	Merit	15
Unit 7	120	Ext	Distinction	32
Unit 8	60	Int	Merit	10
Unit 9	60	Int	Unclassified	0
Unit 10	60	Int	Merit	10
Unit 11	60	Int	Unclassified	0
Unit 12	60	Int	Unclassified	0
Unit 13	60	Int	Unclassified	0
<b>Totals</b>	<b>1080</b>		<b>U</b>	<b>130</b>

The learner has 240 GLH at U.

The learner has sufficient points for an MPP and has achieved N or higher in Units 1, 3, 5 and 7, and P or higher in Units 2, 4 and 6 but has not met the minimum requirement for 900 GLH at Pass or above.

# 10 Resources and support

Our aim is to give you a wealth of resources and support to enable you to deliver BTEC National qualifications with confidence. On our website you will find a list of resources to support teaching and learning, and professional development.

## Support for setting up your course and preparing to teach

### Specification

This specification (for teaching from September 2018) includes details on the administration of qualifications and information on all the units for the qualification.

### Delivery Guide

This free guide gives you important advice on how to choose the right course for your learners and how to ensure you are fully prepared to deliver the course. It explains the key features of BTEC Nationals and covers guidance on assessment (internal and external). The guide tells you where you can find further support and gives detailed unit-by-unit delivery guidance. It includes teaching tips and ideas, assessment preparation and suggestions for further resources.

### Delivery plan

Each plan is designed to provide one way that the BTEC National qualification in your sector could be delivered over one or two years. The Delivery Plan provides guidance as to how the units might be delivered holistically, how the learning aims of units map together and how certain content overlaps and would benefit from co-teaching.

### Schemes of work

Free sample schemes of work are provided for each mandatory unit. These are available in Word™ format for ease of customisation.

### Study skills activities

A range of case studies and activities is provided; they are designed to help learners develop the study skills they need to successfully complete their BTEC course. The case studies and activities are provided in Word™ format for easy customisation.

### myBTEC

myBTEC is a free, online toolkit that lets you plan and manage your BTEC provision from one place. It supports the delivery, assessment and quality assurance of BTECs in centres and supports teachers with the following activities:

- checking that a programme is using a valid combination of units
- creating and verifying assignment briefs (including access to a bank of authorised assignment briefs that can be customised)
- creating assessment plans and recording assessment decisions
- tracking the progress of every learner throughout their programme.

To find out more about myBTEC, visit the myBTEC page on the support services section of our website. We will add the new BTEC National specifications to myBTEC as soon as possible.

## Support for teaching and learning

Pearson Learning Services provides a range of engaging resources to support BTEC Nationals, including:

- revision guides and revision workbooks in e-book and print formats for *Units 1* and *3* (part of the BTEC National in Applied Science series)
- *Units 1, 2, 3* and *8* form part of Student Book 1 and Teacher Pack 1 for the BTEC Nationals in Applied Science. In addition, *Unit 16* is included in Student Book 2 for the BTEC Nationals in Applied Science.

## Support for assessment

### Sample assessment materials for externally-assessed units

Sample assessments are available for the Pearson-set units. One copy of each of these assessments can be downloaded from the website/available in print. For each suite an additional sample for one of the Pearson-set units is also available, allowing your learners further opportunities for practice.

Further sample assessments will be made available through our website on an ongoing basis.

### Sample assessment materials for internally-assessed units

We do not prescribe the assessments for the internally-assessed units. Rather, we allow you to set your own, according to your learners' preferences and to link with your local employment profile.

We do provide a service in the form of Authorised Assignment Briefs, which are approved by Pearson Standards Verifiers. They are available via our website or free on myBTEC.

### Sample marked learner work

To support you in understanding the expectation of the standard at each grade, examples of marked learner work at PM/MD grades are linked to the Authorised Assignment Briefs.

## Training and support from Pearson

### People to talk to

There are many people who are available to support you and provide advice and guidance on delivery of your BTEC Nationals. These include:

- Subject Advisors – available for all sectors. They understand all Pearson qualifications in their sector and so 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 learner work and providing quality assurance through sampling
- Curriculum Development Managers (CDMs) – they are regionally based and have a full overview of the BTEC qualifications and of the support and resources that Pearson provides. CDMs 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.

### Training and professional development

Pearson provides a range of training and professional development events to support the introduction, delivery, assessment and administration of BTEC National qualifications. These sector-specific events, developed and delivered by specialists, are available both face to face and online.

#### 'Getting Ready to Teach'

These events are designed to get teachers ready for delivery of the BTEC Nationals. They include an overview of the qualifications' structures, planning and preparation for internal and external assessment, and quality assurance.

#### Teaching and learning

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.



## Appendix 1 Links to industry standards

BTEC Nationals have been developed in consultation with industry and appropriate sector bodies to ensure that the qualification content and approach to assessment aligns closely to the needs of employers. Where they exist, and are appropriate, National Occupational Standards (NOS) and professional body standards have been used to establish unit content.

## Appendix 2 Glossary of terms used for internally-assessed units

This is a summary of the key terms used to define the requirements in the units.

Term	Definition
Analyse	Learners present the outcome of methodical and detailed examination either: <ul style="list-style-type: none"> <li>• breaking down a theme, topic or situation in order to interpret and study the interrelationships between the parts and/or</li> <li>• of information or data to interpret and study key trends and interrelationships.</li> </ul>
Assess	Learners present a careful consideration of varied factors or events that apply to a specific situation, or identify those which are the most important or relevant and arrive at a conclusion.
Demonstrate	Learners' work, performance or practice evidences the ability to carry out and apply knowledge, understanding and/or skills in a practical situation.
Describe	Learners' work gives a clear, objective account in their own words, showing recall and, in some cases, application of the relevant features and information about a subject. Use of this verb normally requires breadth of content coverage. Evidence will normally be written but could be through presentation or, less frequently, performance or practice.
Determine	Learners use quantitative and/or qualitative information to help analyse and compare findings.
Discuss	Learners consider different aspects of: <ul style="list-style-type: none"> <li>• a theme or topic</li> <li>• how they interrelate</li> <li>• the extent to which they are important.</li> </ul> A conclusion is not required.
Evaluate	Learners' work draws on varied information, themes or concepts to consider aspects such as: <ul style="list-style-type: none"> <li>• strengths or weaknesses</li> <li>• advantages or disadvantages</li> <li>• alternative actions</li> <li>• relevance or significance.</li> </ul> Learners' enquiries should lead to a supported judgement showing relationship to its context. This will often be in a conclusion.

Term	Definition
Explain	Learners' work shows clear details and gives reasons and/or evidence to support an opinion, view or argument. It could show how conclusions are drawn (arrived at). Learners show that they comprehend the origins, functions and objectives of a subject, and its suitability for purpose.
Illustrate	Learners include examples, images or diagrams to show what is meant in a specific context.
Investigate	Knowledge based on personal research and development.
Justify	Learners give reasons or evidence to: <ul style="list-style-type: none"> <li>• support an opinion</li> <li>• prove something right or reasonable.</li> </ul> Use of a given technique/method.
Plan	Learners create a way of doing a task or series of tasks to achieve specific requirements or objectives, showing progress from start to finish.
Predict (make predictions)	Learners can synthesise predictions using applications of relevant knowledge and understanding in a given context.
Prepare	Used with a standard to demonstrate competence in preparation of testing materials, e.g. organic and inorganic substances/solutions.

This is a key summary of the types of evidence used for BTEC Nationals.

Type of evidence	Definition and purpose
Case study	A specific example to which all learners must select and apply knowledge. Used to show application to a realistic context where direct experience cannot be gained.
Development log	A record kept by learners to show the process of development. Used to show method, self-management and skill development.
Observations sheets	A witness statement related to the format of the evidence, e.g. practicals.
Photographic	Used in analysing a simulated crime scene and producing a portfolio of photographic evidence.
Presentation	A visual or audio presentation of findings that demonstrate knowledge and understanding of a concept.
Report writing	A report consisting of analysis of findings, could be through research or primary investigations conducted.

# Pearson

## BTEC Level 3 Nationals

### in

# Forensic and Criminal Investigation

Foundation Diploma in Forensic Investigation

Diploma in Forensic and Criminal Investigation

**Extended Diploma in Forensic and Criminal Investigation**

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Registered Office: 80 Strand, London WC2R 0RL

VAT Reg No GB 278 537121

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ISBN 978-1-4469-3743-3



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