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Introduction

This publication supports your delivery of BTEC Level 3 Nationals Applied Science qualifications and should be read in conjunction with the published specification. It provides an overview of how the qualifications have changed, how the BTEC unit specifications should be used, and how best to deliver the course and assess your learners' progress.

These materials are not prescriptive. You may feel that the course can be delivered and assessed more effectively in a different way. This may be because of the way the qualification is organised within your centre or because a different approach better suits your learners, after taking into consideration their learning styles and prior learning. BTEC qualifications are designed to enable you to plan and deliver programmes that are dynamic and relevant to local needs.

Further information and support
For a complete guide to all support offered by Edexcel at every stage of your BTEC delivery, please refer to BTEC Support. This booklet is available in your Specification Pack.
What’s new for BTEC

Edexcel has redeveloped its suite of BTEC Level 2 First and BTEC Level 3 National qualifications to ensure that they are aligned with the new Qualifications and Credit Framework (QCF). Wherever possible the changes have been minimal, and in all cases BTEC units have retained their key characteristics.

What is the Qualifications and Credit Framework?

The Qualifications and Credit Framework (QCF) is a system whereby credit is awarded for qualifications and units (small steps of learning). It enables learners to work towards qualifications at their own pace and along flexible routes.

All QCF units are published on the National Database of Accredited Qualifications (NDAQ). Every unit and qualification has a credit value showing how much time it takes to complete and a level showing how difficult it is (ranging from Entry Level to Level 8). Learners are given a unique learner number (ULN) where their individual record of credit accumulation is logged. For more information see www.accreditedqualifications.org.uk.

How does this affect the BTEC Level 3 National qualifications?

The new family of BTEC Nationals – which are all at Level 3 – is made up of four sizes of qualification: Certificates, Subsidiary Diplomas, Diplomas and Extended Diplomas. (These qualification names have changed during the revision of BTEC Nationals to meet the QCF structure – please see the table below to compare the new names to the old if you have taught BTEC before.)

The Certificate has been introduced as a new BTEC Level 3 National qualification, to be broadly equivalent to one AS Level. This increases flexibility and improves opportunities for co-teaching with Advanced GCSEs and other qualification types. The BTEC National Certificate will be needed wherever possible in the corresponding BTEC National Subsidiary Diploma, and the BTEC National Diploma in the corresponding BTEC National Extended Diploma.

All BTEC Level 3 National qualifications (whether Certificates, Subsidiary Diplomas, Diplomas and Extended Diplomas) comprise a mix of units, and these can be at different levels, but the majority of units must be at the main level of the qualification: Level 3.

Rules of unit combination have been determined to show how learners can select and combine unit choices to achieve new BTEC Level 3 National qualifications (please see the specification for the list of available units). In some cases there will be mandatory units which all learners must take to achieve their qualification.

The overall grade for any BTEC qualification will be based on the table in the specification that converts pass, merit or distinction unit grades to points and then totals those points.

For full information about these qualification types, rules of unit combination and grading please see the specification.

New features for BTEC units

There are some new features common to all new BTEC units:
- credit level and guided learning hours (GLH) are stated
- expanded guidance is given on delivery and assessment
- BTEC units now contain guidance and mapping to functional skills and personal, learning and thinking skills (PLTS) – so you can embed learning for these skills
- outline learning plans give suggestions for unit delivery and assessment
- a suggested programme of assignments gives ideas for assignments that will cover the unit’s assessment and grading criteria
- each unit suggests how you can link with employers.

BTEC Level 3 National qualifications

<table>
<thead>
<tr>
<th>Certificate</th>
<th>Subsidiary Diploma</th>
<th>Diploma</th>
<th>Extended Diploma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous name</td>
<td>this is new</td>
<td>Award</td>
<td>Certificate</td>
</tr>
<tr>
<td>Credits (minimum)</td>
<td>30</td>
<td>60</td>
<td>120</td>
</tr>
<tr>
<td>Guided learning hours (GLH)</td>
<td>180</td>
<td>360</td>
<td>720</td>
</tr>
<tr>
<td>Broad equivalence</td>
<td>1 AS Level</td>
<td>1 A Level</td>
<td>2 A Levels</td>
</tr>
</tbody>
</table>

This additional information is not meant to be prescriptive. A key feature of BTEC is that you can match your delivery of the qualifications to local needs and circumstances, and to the opportunities that are present in your area to give a real vocational focus. For more information about BTEC units see page 28.

Guided learning hours

Guided learning hours (GLH) comprise all the times when a member of staff (such as a tutor, trainer or facilitator) is present to give guidance (‘contact time’). This includes lectures, tutorials, and supervised study in, for example, learning resource centres and workshops. It also includes time spent with learners observing and assessing their achievements as they work towards their assignments.

Functional skills

Functional skills have replaced key skills. These are a set of standards that establish a benchmark in English, mathematics and ICT. Functional skills are available from Entry Level to Level 2.

BTEC specifications now offer guidance on how these functional skills can be embedded in your delivery of each unit. Please note: functional skills can be tested while delivering a BTEC course but they are not an integral part of the qualification. They are designed to be assessed by externally set and marked tests.

Personal, learning and thinking skills (PLTS)

BTEC Level 3 National units offer guidance and signposting to help you develop learners’ personal, learning and thinking skills. Along with functional skills, these are seen as key elements for success in learning, life and work. Note that PLTS are not a compulsory or integral component of the BTEC Level 3 National, but should you wish to integrate your PLTS delivery with this qualification we provide this guidance for you to do so.

The PLTS framework consists of six groups of skills:
- independent enquiry (IE)
- creative thinking (CT)
- reflective learning (RL)
- team working (TW)
- self-management (SM)
- effective participation (EP).

These have connected outcome statements (to view these visit www.qcda.org.uk).

Although each skill set is distinctive they may be interconnected, and any assignment or learning experience may explore one or more PLTS. BTEC Level 3 National qualifications offer the opportunity to cover PLTS, but in order for learners to recognise this coverage the PLTS would need to be made explicit at delivery. An effective way to record competence in PLTS is by using a tracking system that is linked to the PLTS references in the unit specifications.

WorkSkills

Edexcel has developed a range of WorkSkills qualifications at Entry 3, Level 1 and Level 2 that may also be studied alongside BTEC Level 3 Nationals. WorkSkills comprise a range of units that focus on personal development, work, social and domestic skills.

For more information on WorkSkills see www.edexcel.com/workskills

So, why choose BTEC?

BTECs are an established and highly successful alternative to general qualifications, suitable for a wide range of learners. As work-related qualifications, they are designed to accommodate the needs of employers as well as allowing progression to university.

By nature BTECs provide a more practical, real-world approach to learning alongside a theoretical background, giving learners the knowledge, understanding and skills that they need to prepare for employment. BTECs also provide career development opportunities for those already in work. They can be taken as well as, or instead of, GCSEs and Advanced GCSEs in schools and colleges.

Comprising individual units which can be built to form a qualification at a size that is suited to the learner, BTECs can be delivered as a full-time or part-time course. Each unit is assessed through the completion of assignments that are designed by you as tutor and that call on a range of evidence types. Such flexibility enables you to deliver a qualification that is just right for your learners.
# What's new for BTEC Level 3 Nationals in Applied Science

Units have been revised and updated so that they can be mapped to the Qualifications and Credit Framework (QCF). This table summarises the specification changes unit by unit. For a complete list of new units, including rules of combination and mandatory/optional unit status, please see the specification.

<table>
<thead>
<tr>
<th>New units</th>
<th>Old units</th>
<th>Mapping/comments</th>
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<tbody>
<tr>
<td><strong>Number</strong></td>
<td><strong>Name</strong></td>
<td><strong>Number</strong>            <strong>Name</strong></td>
</tr>
<tr>
<td>1</td>
<td>Fundamentals of Science</td>
<td>Unit 1 Fundamentals of Science</td>
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<tr>
<td></td>
<td></td>
<td>This unit no longer covers electricity and electromagnetic radiation. LO4 is now:</td>
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<td></td>
<td></td>
<td>4 Be able to communicate scientific information.</td>
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<tr>
<td>2</td>
<td>Working in the Science Industry</td>
<td>Unit 2 Working in the Science Industry</td>
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<tr>
<td></td>
<td></td>
<td>The same unit with improved learning outcomes and content, added assessment and</td>
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<tr>
<td></td>
<td></td>
<td>delivery guidance, outline learning plan, and suggested programme of assignments.</td>
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<tr>
<td>3</td>
<td>Scientific Investigations</td>
<td>Unit 3 Scientific Investigation</td>
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<td></td>
<td></td>
<td>The same unit with improved learning outcomes and content, added assessment and</td>
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<td></td>
<td></td>
<td>delivery guidance, outline learning plan, and suggested programme of assignments.</td>
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<tr>
<td>4</td>
<td>Scientific Practical Techniques</td>
<td>Unit 4 Scientific Practical Techniques</td>
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<td></td>
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<td>Learning outcomes are now:</td>
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<tr>
<td></td>
<td></td>
<td>1 Be able to use analytical techniques</td>
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<td></td>
<td>2 Be able to use scientific techniques to separate and assess purity of substances</td>
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<td></td>
<td>3 Be able to use instruments/sensors for scientific investigations.</td>
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<tr>
<td>5</td>
<td>Perceptions of Science</td>
<td>Unit 5 Perceptions of Science</td>
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<td></td>
<td></td>
<td>The same unit with improved learning outcomes and content, added assessment and</td>
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<td></td>
<td></td>
<td>delivery guidance, outline learning plan, and suggested programme of assignments.</td>
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<tr>
<td>6</td>
<td>Using Mathematical Tools in Science</td>
<td>Unit 6 Application of Numbers for Science Technicians</td>
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<td></td>
<td></td>
<td>This unit covers the same content as the previous specification, with greater</td>
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<td></td>
<td></td>
<td>emphasis on the importance of accurately collecting and recording data.</td>
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<td>7</td>
<td>Mathematical Calculations for Science</td>
<td>Unit 7 Mathematics for Science Technicians</td>
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<td></td>
<td>This unit now covers the use of algebra, trigonometry and calculus to solve</td>
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<tr>
<td></td>
<td></td>
<td>science problems.</td>
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<tr>
<td>8</td>
<td>Using Statistics in Science</td>
<td>Unit 8 Statistics for Science Technicians</td>
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<td></td>
<td></td>
<td>Learning outcomes are now:</td>
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<tr>
<td></td>
<td></td>
<td>1 Be able to use statistical techniques to investigate scientific problems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 Be able to perform statistical tests to investigate scientific problems.</td>
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<tr>
<td>9</td>
<td>Informatics in Science</td>
<td>Unit 9 Informatics</td>
</tr>
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<td></td>
<td></td>
<td>Learning outcomes are now:</td>
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<tr>
<td></td>
<td></td>
<td>1 Know how informatics is used in science</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 Be able to collect scientific data</td>
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<tr>
<td></td>
<td></td>
<td>3 Be able to store and analyse scientific data.</td>
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<tr>
<td>10</td>
<td>Using Science in the Workplace</td>
<td>Unit 10 Using Science in the Workplace</td>
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<td></td>
<td>The same unit with improved learning outcomes and content, added assessment and</td>
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<td></td>
<td>delivery guidance, outline learning plan, and suggested programme of assignments.</td>
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<tr>
<td>11</td>
<td>Physiology of Human Body Systems</td>
<td>Unit 11 Physiology of Human Body Systems</td>
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<tr>
<td></td>
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<td>Learning outcomes are now:</td>
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<tr>
<td></td>
<td></td>
<td>1 Know the levels of organisation within the human body</td>
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<td>2 Be able to relate the structure of the circulatory system to its function in</td>
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<td>a multi-cellular organism</td>
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<td>3 Be able to relate the structure of the respiratory system to its function</td>
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<td>4 Be able to relate the structure of the digestive system to its function</td>
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<td>5 Understand the immunological function of the lymphatic system.</td>
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<tr>
<td>12</td>
<td>Physiology of Human Regulation and</td>
<td>Unit 12 Physiology of Human Regulation and Reproduction</td>
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<tr>
<td></td>
<td>Reproduction</td>
<td>Learning outcomes are now:</td>
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<tr>
<td></td>
<td></td>
<td>1 Know the importance of the regulation of body fluids in the human body</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 Know the organisation and function of the nervous system</td>
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<td></td>
<td>3 Understand the homeostatic mechanisms used by the body to maintain the internal</td>
</tr>
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<td></td>
<td></td>
<td>environment</td>
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<td>4 Understand how the structure of the human reproductive system relates to the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>functions</td>
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<tr>
<td>13</td>
<td>Biochemistry and Biochemical Techniques</td>
<td>Unit 13 Biochemical Techniques</td>
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<tr>
<td></td>
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<td>Learning outcomes are now:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 Be able to investigate properties of water and biological molecules in living</td>
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<tr>
<td></td>
<td></td>
<td>organisms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 Understand the structure of proteins</td>
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<td></td>
<td>3 Be able to investigate the factors that affect the activities of enzymes in</td>
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<tr>
<td></td>
<td></td>
<td>biological systems</td>
</tr>
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<td></td>
<td></td>
<td>4 Know the difference between aerobic and anaerobic respiration.</td>
</tr>
<tr>
<td>14</td>
<td>Energy Changes, Sources and Applications</td>
<td>Unit 14 Energy Changes, Sources and Applications</td>
</tr>
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<td>Learning outcomes are now:</td>
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<tr>
<td></td>
<td></td>
<td>2 Be able to investigate how changes of temperature or physical state relate to</td>
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<tr>
<td></td>
<td></td>
<td>changes in internal energy</td>
</tr>
<tr>
<td>15</td>
<td>Microbiological Techniques</td>
<td>Unit 15 Microbiological Techniques</td>
</tr>
<tr>
<td></td>
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<td>Learning outcomes are now:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Be able to determine the factors that influence the growth of micro-organisms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 Know how to identify micro-organisms.</td>
</tr>
<tr>
<td>New units</td>
<td>Old units</td>
<td>Mapping/comments</td>
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<tr>
<td>-----------</td>
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</tr>
<tr>
<td><strong>Unit 16</strong> Chemistry for Biology Technicians</td>
<td>Unit 16 Chemistry for Biology Technicians</td>
<td>Learning outcomes 2, 3 and 4 are now:  2 Be able to show how rates of reaction are affected by varying the reaction conditions  3 Be able to interpret key features of equilibrium processes  4 Be able to demonstrate the structure and properties of simple organic molecules.</td>
</tr>
<tr>
<td><strong>Unit 17</strong> Electrical Circuits and their Applications</td>
<td>Unit 17 Electrical Circuits and their Industrial Applications</td>
<td>Learning outcomes are now:  1 Know principal electrical terms, quantities and relationships  2 Be able to measure electrical values by construction of series and parallel circuits  3 Understand the characteristics of AC and DC circuits  4 Understand the health and safety aspects of working with electricity  5 Know the uses of transducers and measurement devices.</td>
</tr>
<tr>
<td><strong>Unit 18</strong> Genetics and Genetic Engineering</td>
<td>Unit 18 Genetics and Genetic Engineering</td>
<td>Learning outcomes 1-3 are now:  1 Understand the process of protein synthesis  2 Be able to investigate the process of cell division in eukaryotic cells  3 Understand the principles of Mendelian genetics.</td>
</tr>
<tr>
<td><strong>Unit 19</strong> Practical Chemical Analysis</td>
<td>Unit 19 Practical Chemical Analysis</td>
<td>Learning outcomes 1-3 are now:  1 Be able to use standard solutions in quantitative analysis  2 Be able to analyse data from spectroscopic techniques to provide analytical information about chemical substances  3 Be able to use chromatographic techniques to analyse mixtures of chemical substances.</td>
</tr>
<tr>
<td><strong>Unit 20</strong> Medical Physics Techniques</td>
<td>Unit 20 Medical Physics Techniques</td>
<td>The same unit with improved learning outcomes and content, added assessment and delivery guidance, outline learning plan, and suggested programme of assignments.</td>
</tr>
<tr>
<td><strong>Unit 21</strong> Biomedical Science Techniques</td>
<td>Unit 21 Biomedical Science Techniques</td>
<td>Learning outcomes 4 and 5 are:  4 Know the importance of cell pathology as a diagnostic tool  5 Understand how the chemical make-up of the body influences health and disease.</td>
</tr>
<tr>
<td><strong>Unit 22</strong> Chemical Laboratory Techniques</td>
<td>Unit 22 Chemical Laboratory Techniques</td>
<td>Learning outcomes are now:  1 Be able to prepare substances  2 Be able to measure percentage yield and percentage purity  3 Be able to carry out qualitative analysis of compounds  4 Be able to carry out quantitative analysis of compounds within a matrix.</td>
</tr>
<tr>
<td><strong>Unit 23</strong> Science for Environmental Technicians</td>
<td>Unit 23 Science for Environmental Technicians</td>
<td>The same unit with improved learning outcomes and content, added assessment and delivery guidance, outline learning plan, and suggested programme of assignments.</td>
</tr>
<tr>
<td><strong>Unit 24</strong> Principles of Plant and Soil Science</td>
<td>Unit 24 Principles of Plant and Soil Science</td>
<td>The same unit with improved learning outcomes and content, added assessment and delivery guidance, outline learning plan, and suggested programme of assignments. In addition learning outcome 4 is now:  4 Know the ways in which people can influence plant and soil processes.</td>
</tr>
<tr>
<td><strong>Unit 25</strong> Electronics for Science Technicians</td>
<td>Unit 25 Electronics for Science Technicians</td>
<td>The same unit with improved learning outcomes and content, added assessment and delivery guidance, outline learning plan, and suggested programme of assignments.</td>
</tr>
<tr>
<td><strong>Unit 26</strong> Industrial Chemical Reactions</td>
<td>Unit 26 Industrial Applications of Chemical Reactions</td>
<td>Learning outcomes are now:  1 Understand how to calculate enthalpy changes from experimental and supplied data  2 Be able to investigate rates of chemical reactions in terms of the factors that influence them  3 Understand the principles of chemical equilibrium  4 Understand how physical chemistry concepts are applied to the control of industrial processes.</td>
</tr>
<tr>
<td><strong>Unit 27</strong> Chemical Periodicity and its Applications</td>
<td>Unit 27 Chemical Periodicity and its Applications</td>
<td>Learning outcomes are now:  1 Know how physical and chemical properties of elements and their compounds are related to the positions of the elements in the periodic table  2 Understand how the properties of substances influence their production and uses  3 Know analytical procedures based on oxidation and reduction  4 Be able to investigate practically a range of reactions involving solutions of transition metal ions.</td>
</tr>
<tr>
<td><strong>Unit 28</strong> Industrial Applications of Organic Chemistry</td>
<td>Unit 28 Industrial Applications of Organic Chemistry</td>
<td>Learning outcomes are now:  1 Know the properties of hydrocarbons  2 Know the properties of simple functional group compounds  3 Understand the importance of isomerism  4 Be able to carry out reactions involving organic compounds.</td>
</tr>
<tr>
<td><strong>Unit 29</strong> Physiological Investigations</td>
<td>Unit 29 Physiological Investigations</td>
<td>The same unit with improved learning outcomes and content, added assessment and delivery guidance, outline learning plan, and suggested programme of assignments.</td>
</tr>
<tr>
<td><strong>Unit 30</strong> Medical Instrumentation</td>
<td>Unit 30 Medical Instrumentation</td>
<td>The same unit with improved learning outcomes and content, added assessment and delivery guidance, outline learning plan, and suggested programme of assignments.</td>
</tr>
</tbody>
</table>
## What's new for BTEC

<table>
<thead>
<tr>
<th>New units</th>
<th>Old units</th>
<th>Mapping/comments</th>
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<tbody>
<tr>
<td><strong>Number</strong></td>
<td><strong>Name</strong></td>
<td><strong>Number</strong></td>
</tr>
<tr>
<td>Unit 31</td>
<td>Criminology</td>
<td>Unit 31</td>
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<td>Unit 32</td>
<td>Forensic Evidence Collection and Analysis</td>
<td>Unit 32</td>
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<td>Unit 33</td>
<td>Forensic Photography</td>
<td>Unit 33</td>
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<tr>
<td>Unit 34</td>
<td>Criminal Psychology</td>
<td>Unit 34</td>
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<tr>
<td>Unit 35</td>
<td>Applications of Forensic Psychology</td>
<td>Unit 35</td>
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<tr>
<td>Unit 36</td>
<td>Forensic Fire Investigation</td>
<td>Unit 36</td>
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<td>Unit 37</td>
<td>Forensic Science Informatics</td>
<td>Unit 37</td>
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<td>Unit 38</td>
<td>Traffic Accident Investigation</td>
<td>Unit 38</td>
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<td>Unit 39</td>
<td>Criminal Investigation Procedures</td>
<td>Unit 39</td>
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<td>Unit 40</td>
<td>Criminal Investigation in Practice</td>
<td>Unit 40</td>
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<td>Unit 41</td>
<td>Clinical Psychology</td>
<td>Unit 41</td>
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<td>Unit 42</td>
<td>Geology of Natural Resources</td>
<td>Unit 42</td>
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<tr>
<td>Unit 43</td>
<td>Diseases and Infections</td>
<td>Unit 43</td>
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<tr>
<td>Unit 44</td>
<td>Astronomy</td>
<td>Unit 44</td>
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</table>
Yale College

Yale College is a post-16 and adult education tertiary college providing education and training for young people and adult learners within the Wrexham area. It offers a broad curriculum at its two sites in Wrexham, which include a new engineering and construction campus, and through 13 outreach centres. Yale College offers the BTEC National in Applied Science (Medical Science).

Why did you choose to run this BTEC course?
There were several reasons for choosing the BTEC National in Applied Science. Our BTEC First in Applied Science programme and its GNVQ Intermediate predecessor had sustained good enrolment numbers, retention and attainment. A significant number of learners on this programme were seeking a progression route which would allow further development of the research, organisation and study skills rehearsed at Level 2 through continuous assessment of portfolio evidence. In addition, some learners enrolled on AS programmes were not suited to this mode of study and assessment. So, the science curriculum teams and college management were keen to provide a viable, alternative Level 3 pathway.

Through an established forum at the college, which provides the opportunity for programme coordinators to meet and share good practice, resources and experience, decision-makers were aware that BTEC Nationals were running successfully in other curriculum areas of the college.

The college has a well-established culture of celebrating achievement on both academic and vocational programmes. Ultimately I believe it was this openness, support for and celebration of achievement across academic and vocational programmes that enabled us to expand successfully in this area of provision.

What have you enjoyed most about the course as a tutor?
I have enjoyed working with the team to develop a programme which combines rigour in teaching scientific concepts with a meaningful vocational context. I thrive on adopting a variety of classroom roles, such as deliverer, assessor and facilitator, as well as the ‘made-up’ roles for role plays in the context of assignments.

It is rewarding to work in partnership with learners to map their progress and watch them grow in confidence as individuals and members of teams. Links with colleagues in industry has enabled us to develop purposeful, realistic and challenging scenarios to meet the assessment criteria.

How has your teaching changed since you started to deliver the course?
We are upholding the BTEC National in Applied Science as our flagship programme. As a programme team we are conveying the message to learners that they are working in a professional environment to professional standards. I have established a shared code of conduct so that in class we act as ‘critical friends’ in the assessment of other members of the group.

I look to provide an integrated experience for learners, striking a balance between tutor-led delivery, group work, individual learner presentation and research, site visits and visiting speakers. The programme lends itself well to the integration of ‘cross-cutting’ themes in delivery, such as health and safety, functional skills, recognition of opportunities in Welsh industry and entrepreneurship.

I also use different modes of presentation, consistent with the spirit of the BTEC approach. Where new approaches have been successful in the delivery of vocational programmes, these are integrated into the teaching of AS/A2 programmes, and vice versa.

What changes have you observed in learners as they have progressed through the course?
Having attained the pass grading criteria, learners can be motivated to reach higher grading criteria and conscientiously follow up action plans devised during assessment to achieve their goals.

Members of the technical staff have commented on the well-developed manual dexterity of the BTEC National learners, as evidenced by their ability to plan and make adaptations in technical processes or equipment.

The learners in this cohort are members of a single tutor group and have assumed a strong group identity in the course of their learning. They have also worked together on cross-college extracurricular activities, such as fundraising for charity.

Learners have become more confident in making group presentations, and they have become more aware of what is required when providing assignment evidence to suit the ‘audience’ defined in the brief. For example, when a brief requires developing a training package, they will ensure that the material has a consistent house style format and adopts user-friendly language suitable for laboratory trainees. It has also become apparent that, independently of their tutors, learners assign and assume responsibility for assigned roles in group work.

Many have learned to focus their attention and use their time more efficiently. For example, they will invest time in preparing a list of questions for a visit to industry to ensure the requirements for specific grading criteria are covered.

Can you give any examples of reluctant or previously unsuccessful learners who have ‘blossomed’ since embarking on a BTEC course?
Some learners have previously not completed or have under-attained on AS programmes. They have now grown in confidence as the year has progressed and have been able to track their progress across the BTEC National in Applied Science units.

The style of learning on the programme encourages learners to try out new things and develop new skills, and the confidence they build helps motivate them to higher-than-expected achievements.
In 2009 Park Lane College Keighley became a part of the new Leeds City College, one of the largest further education colleges in the country. It has five main sites: Horsforth Campus, Keighley Campus, Thomas Danby Campus, Park Lane Campus and the Technology Campus, with each campus linked to specialist provision. The college offers the BTEC National in Applied Science (Laboratory and Industrial).

Why did you choose to run this BTEC course? We chose this course because as a fairly small centre we wanted a general Level 3 science course that would appeal to a wide range of learners. To widen appeal we imparted three units from the forensic science pathway under the facility to ‘meet local needs’. We recognised that there were many learners who either did not want to take A-levels or would not be accepted onto an A-level programme because of weaknesses in their GCSE profile. An assignment-based course had much greater appeal to these learners. We have found that the course has enabled learners to progress to a wide range of jobs and higher education courses, including forensic science.

What have you enjoyed most about the course as a tutor? As a tutor I have enjoyed delivering the practical aspects of this course. Most learners have found that they are doing much more practical work than they have done before and they readily begin to take ownership of their investigations. Learners have tackled assignments according to their ability; nearly all have been able to demonstrate success at a pass level, but all are stretched by the challenges of the distinction grading criteria.

How has your teaching changed since you started to deliver the course? Since starting to deliver this course my teaching has changed in that I am now much more confident about allowing learners to discover for themselves through practical investigations or research. Working within the scope of the assignment brief, learners can produce individual reports from their own research, rather than being hemmed in by examination specifications.

What changes have you observed in learners as they have progressed through the course? Most learners have matured considerably during the course and many have realised they can take ownership of their study by using their tutor as a resource. Learners have benefited from receiving feedback on their early assignments and many found this gave a boost to their confidence. The effect this has had on some learners has been remarkable. Once they realise they can be successful, they have become determined to maintain a high standard.

Can you give any examples of reluctant or previously unsuccessful learners who have ‘blossomed’ since embarking on a BTEC course? Many learners have benefited from this course despite setbacks in their learning in the past. One learner in our current cohort had transferred from an AS course. He was quick to understand new ideas but found it difficult to follow them through. Many of his assignments in the first year of the course were not particularly good. He knew he could do better, and making a UCAS application at the start of the year and quickly receiving a conditional offer to study biology was the incentive he needed to realise his potential. He is now achieving merit and distinction grades, and we expect him to progress on to Hull, his chosen university.

Another learner in this cohort came straight from school with an interest in science, and with GCSE C grades to back it up, though without maths and English. He has been a very conscientious learner and because he kept up to date with assignments, he had time to implement the action plans in order to improve his grades. He has been offered places at universities in Leeds and Bradford.
Getting started: planning course delivery

Good planning is the first step to successful BTEC delivery and assessment. It is the best way of making sure that everything is in place and that your unit coverage is robust and achievable. This guide should help you get started.

The BTEC assessment and delivery process

Overview of roles and responsibilities

<table>
<thead>
<tr>
<th>Tutors/assessors</th>
<th>Learners</th>
<th>Internal verifiers*</th>
<th>Programme managers/heads of department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read the specification Work with colleagues in your department, planning the course as a team Design assignments which are suited to local and learner needs and matched to unit grading criteria Action the internal verifier’s advice on planning</td>
<td>Manage and organise their own time to prepare evidence for assignments</td>
<td>Support programme planning Arrange standardisation meetings across teams and multi-sites Ensure an effective system for recording learner achievement is in place Advise programme team on any training needs</td>
<td>Manage the team to device assessment programme in collaboration with tutors (assessors) and internal verifier(s) Prepare resources plan to match assignment programme Manage timetable and room allocation Organise a tracking mechanism for learner achievement</td>
</tr>
<tr>
<td>Planning Deliver unit content and assignments</td>
<td>Participate fully in learning Produce work for assessment</td>
<td>Provide advice and support to assessors on regular basis Advise on opportunities for evidence generation and collection Advise on the appropriateness of assessment evidence with regard to level, sufficiency, authenticity, validity and consistency Advise on the interpretation of national standards and undertake standardisation exercise Keep records of the verification process Liaise with Edexcel assessment associate where appropriate</td>
<td>Take part in the programme Monitor delivery Organise regular team meetings Coordinate tutor/assessor activity Liaise with the internal verifier(s) and head internal verifier(s) Deal with learner issues Oversee maintenance of learner records</td>
</tr>
<tr>
<td>Implementing Action internal verifier’s advice on assignment design</td>
<td>Check the validity and sufficiency of the evidence with the assessor Review opportunities for achieving grading criteria Participate in self and peer assessment activities where appropriate</td>
<td>Check if assignments are fit for purpose Use their subject specialism to sample assignments to check the quality of assessment and to ensure that it is consistent, fair and reliable Ensure own assessment decisions are sampled when teaching on the programme</td>
<td>Collaborate with internal verifier(s) and lead internal verifier(s) to maintain the programme Check the validity of overall verification programme Coordinate awarding body requirements Update internal verifier team on current practice Respond to any awarding body action</td>
</tr>
<tr>
<td>Internal Verifying</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedback</td>
<td></td>
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</tbody>
</table>

* Lead internal verifiers who have passed the new OSCA2 test can seek certification of learner work for the programme(s) they manage without annual external sampling. (Some centres may be randomly sampled.)

* Some of these functions may be undertaken by the lead internal verifier (see page 48).
Overview of year

- Decide which units are being delivered and plan year to timetable
- Plan internal verification activities
- Internal verifiers check assignment briefs prior to issue to learners and build in team standardisation activities**
- Internal verifiers sample learner assessment* **
- Successful completion of OSCA2* by lead internal verifier
- Check assignments to track unit coverage
- Formative assessment tracking for learners
- Summative unit grading and reporting to Edexcel at end of programme
- Learner achievement and certification
- Setting expectations

** OSCA2 is the online standardisation test that would give a lead internal verifier, and consequently the programme(s) they manage, accredited status. With this status a lead internal verifier can seek certification of learners' work during the period of that accreditation without annual external sampling. (Some centres may be randomly sampled.)

** Where the centre has a lead internal verifier who has passed the OSCA2 test, this process is coordinated by them.

Learner induction
It is crucial that you familiarise your learners with how BTEC delivery and assessment work. Consider developing learners’ understanding of:

- the specification (structure, content, grading grids, level of programme and equivalency)
- the purpose of the assignment briefs
- the relationship between the tasks given in an assignment and the grading criteria
- the way that the BTEC grading grids work in relation to their prior experience of other assessment models
- internal assessment procedures and centre policies
- the concept of deadlines and hand-in dates
- the concept of vocational and work-related learning
- learner responsibility.

** Setting expectations**
It is common practice to provide induction books for learners to sign at the beginning of the programme. These could set out your centre’s expected rules and recommendations, for example adherence to health and safety legislation, and your centre’s plagiarism recommendations, for example adherence to health and safety legislation, and your centre’s plagiarism recommendations, for example adherence to health and safety legislation, and your centre’s plagiarism recommendations, for example adherence to health and safety legislation, and your centre’s plagiarism recommendations, for example adherence to health and safety legislation, and your centre’s plagiarism recommendations, for example adherence to health and safety legislation, and your centre’s plagiarism recommendations.

You might decide to show your new learners some work from previous years. This will give them a realistic idea of what is required and how assessment is carried out for a unit. This will take away some of the fear of assessment.

Progression
It is your duty to provide learners with clear guidance on progression and models of continued study that are relevant to their abilities. For more information on how learners might progress from a BTEC Level 3 National, please see www.btec.co.uk.

Edexcel’s Study Skills Guides
Edexcel publishes free study guides for BTEC Level 3 National learners. These provide guidance on:

- self-assessment of strengths so learners can identify the best way for them to learn
- time management
- getting the most from work experience and special events
- working with others
- finding and using resources
- organising, interpreting and presenting information
- making presentations
- tackling assignments (including a worked assignment from a learner perspective).

External links
All work-related programmes benefit from external links with the vocational sector. These links could be developed in many ways:

- provision of ‘live’ case study material that is company- or organisation-based
- learner visits to occupational settings
- professional input from practitioners, especially where vocational expertise is clearly identified in the delivery section of the units
- work placements that are specifically related to the qualification
- tutor placements to enhance vocational expertise.

Always check the vocational relevance of assignments. You can ensure vocational relevance by providing opportunities for learners to acquire vocational language and skills. For example, an assignment might introduce learners to volumetric analysis, giving them the opportunity to handle the equipment used for this purpose, make use of the equations required for such an analysis, and carry out different types of titrations. Another approach is to set the assignment within a strong vocational context. For example, learners could role-play scene-of-crime officers at a simulated crime scene and then role-play forensic scientists analysing the evidence found at the crime scene.

Forging links with local businesses and industry
External links can be very helpful in providing vocational relevance to the programme, particularly where some use of science within the business can be clearly identified. Suitable businesses to approach might include local nurseries, garden centres and even supermarkets, in addition to companies operating in more obvious science-based industries. The process of forging links is considerably eased if you can obtain introductions to businesses through any contacts of the parents, friends or families of learners (and colleagues). Another useful starting point is the governing body of your institution, as there are usually some representatives from local businesses, and they are likely to be supportive of the programmes running within the centre.

It can be helpful to provide any business contact with a copy of the specification, marking the areas in which the contact’s business may be a useful source of information. Whenever possible, also highlight any potential benefit to the business through the link with the course. For example, better community relationships may be developed through developing learner understanding of the processes within the business.

Work experience for learners on applied science programmes can be difficult to arrange, particularly for...
those on the forensic science pathway, but is always of great benefit when it can be organised. If work experience within a science-based organisation, or one in which science is utilised, cannot be arranged, do not underestimate the value of a work placement for helping learners develop an insight into the application of general work ethics and practices.

**Good teaching practice and resources**

**Staffing**
All staff should be appropriately qualified to teach this course. Many tutors delivering the BTEC Nationals in Applied Science have a degree in the subject area and relevant vocational expertise. Tutors should have subject-specific knowledge for the units that they deliver.

**Familiarity with current professional practice**
It is important to have knowledge of current professional practice in order to plan for each specialist area. It is a feature of the design of BTEC qualifications that they have the flexibility to respond to National Occupational Standards in each area as current practice changes. They also offer the opportunity for innovative approaches to teaching and learning.

**Additional specialist practitioners**
You may employ specialist practitioners, taking care that legal requirements are met. Where external tutors are delivering units, the internal verifier should carry out close monitoring to help ensure the quality of the assessment process. Learning needs specialists with a keen interest in the science sector can be very useful in supporting the growth and development of individuals’ skills.

**Awareness of learners requiring reasonable adjustment**
Be aware of individual requirements and ensure that learners can achieve the unit grading criteria in all of the units that the planned programme contains. You are free to make adjustments to programme delivery to ensure that learners can be guaranteed gaining the qualification if they comply with all unit grading demands (for more information see the panel on this page).

**Learning resources**
It is essential to ensure that there is a range of current resource material to support the programme, such as textbooks, videos, magazines, journals and other publications, and access to websites.

### What is a reasonable adjustment?
Reasonable adjustments are arrangements which give a learner access to a qualification. Reasonable adjustments must be agreed at the pre-assessment planning stage and comprise any action that helps to reduce the effect of a disability or difficulty which places the learner at a substantial disadvantage in the assessment. For example, these actions might involve changing or adapting the assessment method, adapting assignment materials or using assistive technology. Reasonable adjustments must not affect the reliability or validity of assessment outcomes and they must not give the learner an assessment advantage over other learners undertaking the same or similar assignments.

### How do I apply for a reasonable adjustment for internally assessed BTEC qualifications?
For BTEC qualifications that are internally assessed, centres do not need to apply to Edexcel to implement a reasonable adjustment. However, centres must only make reasonable adjustments in line with Edexcel policy and must keep a record on Form RA1, which can be found on the Edexcel website.

### Make your optional unit choices carefully
Some IT systems might block access to some websites which need to be accessed for certain research activities in forensic science. In addition, you may be unable to arrange access to relevant equipment. In these cases you will need to provide learners with sample data instead. For all units you must read the assessment criteria and guidance carefully to ensure that you can fully meet the resource requirements.

### Sufficient resources to meet the number of learners
Your centre signs a commitment to ensure adequate provision as part of the approval process. This must be adhered to in all cases so that learners are guaranteed the very best provision a centre can provide. Ongoing Edexcel quality assurance processes and centre risk assessment will check that the centre has sufficient resources to support the delivery of the programme and that the centre has made provision to meet any specialist resource requirements at the approval stage.

Check the unit content to ensure that you have adequate equipment and appropriate technology, and that well-trained staff will be available to deliver the unit at an appropriate and competent level. For example, the practical chemical analysis unit cannot be taught without equipment to carry out wet chromatography techniques. Likewise, forensic photography cannot be taught without single-lens reflex or digital cameras.

Some centres are forced to conduct many of their assignments through group work or to constrain their delivery styles because they have insufficient resources.
Planning unit delivery

BTEC qualifications are designed to be flexible in their delivery and assessment, giving you the opportunity to construct and deliver programmes to suit your resources and learners. There are two main methods of approaching qualification delivery: single unit delivery or integrated delivery.

Single unit delivery

BTEC qualifications comprise individual units that represent clusters of learning outcomes. For many sectors, a unit-by-unit approach to delivery is a valid and appropriate method for meeting the learning outcomes and delivering the unit content within the specification. Vocational applications of knowledge gained through the unit-by-unit assignments allow learners to reflect on their practice, resulting in focused and in-depth evaluations.

Integration of units

For other sectors, however, it is essential that learners know how the content covered by several units interrelates, as it would in the world of work. In these sectors unit delivery is best integrated, with assignment evidence mapped across two or more units. Integrated delivery is one of the distinct strengths of BTEC qualifications and can lead to a deeper practical and vocational understanding of the content.

Delivering the BTEC Level 3 Nationals in Applied Science

You can take different approaches to the delivery of BTEC Nationals in Applied Science. You have a great deal of autonomy in deciding the approach which will best suit your learners.

It is possible to integrate unit delivery where units overlap or in the course of developing learners’ understanding of specific topics. For example, if Unit 11: Physiology of Human Body Systems is being taught as an optional unit, then it may be appropriate to start with some of the content from Unit 1: Fundamentals of Science, particularly the basics of cell structure and function and the different types of tissue, and to integrate this material with the work on tissues, organs and body systems required for Unit 11.

Where a unit demands the use of practical skills and techniques that might have a wider application, look for other units that also utilise these skills – perhaps ones with a specialist vocational emphasis – and see if some grading criteria from two or more units can be met by a single assignment (or set of assignments).

However, it is equally acceptable to take a unit-by-unit approach if this is more appropriate for your circumstances, perhaps because of timetabling constraints or because this approach suits the dominant learning style of your learners.

Developing practical skills

It is good practice to provide opportunities for your learners to practice and develop practical skills before being assessed on the use of those skills.

Referring

Encourage learners to adopt formal referencing in their work and to take good records or notes. This is always valuable as it allows learners to return to useful sources. Try by the end of the programme to make referencing a matter of routine for learners. Bibliographies and/or referencing methodologies can be simple or complex, depending on the capability of individuals. Remember that learners are being prepared for progression.

Can I co-teach BTEC with Advanced GCEs?

• There may be opportunities to co-teach BTEC Nationals with Advanced GCEs. However, it is important that there is clear differentiation between BTEC assignments and GCE coursework.
• You must ensure that the work produced meets the BTEC unit content requirements and that coverage is not compromised.
• Remember: assessment for BTEC should be undertaken within a vocational context and must fulfil the unit grading criteria.
• Where there are a number of assessors working on a BTEC programme, they should be involved in standardisation exercises to ensure consistency of assessment decision-making.
• There must be a robust and effective internal verification process in place.

For more information about BTEC assessment and internal verification, please see pages 48–49.

Selecting the right units

• Look to the specification for information on which units are mandatory and which are optional, and the specific rules of unit combination for each qualification (Certificate, Subsidiary Diploma, Diploma, Extended Diploma).
• Consider which units your centre is best equipped to deliver (consider staffing, expertise, resources).
• Give learners a choice of units so they might follow a course that is appropriate to their needs, abilities and interests.

A suggested course structure

The tables here provide suggestions as to how you might choose to structure a BTEC Level 3 National Applied Science course. Refer to the specification to check other optional units available, unit credits and rules of unit combination. It is important that you make unit choices that are relevant to your learners and can be delivered through the resources available in your centre.

BTEC Level 3 National Certificate in Applied Science:
three mandatory units that provide for a combined total of 30 credits.

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Term 1</th>
<th>Term 2 and Term 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1: Fundamentals of Science (10 credits, mandatory)</td>
<td>Unit 2: Working in the Science Industry (10 credits, mandatory)</td>
<td>Unit 4: Scientific Practical Techniques (10 credits, mandatory)</td>
</tr>
</tbody>
</table>

BTEC Level 3 National Subsidiary Diploma in Applied Science:
three mandatory units plus optional units that provide for a combined total of 60 credits.

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Term 1 and Term 2</th>
<th>Term 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1: Fundamentals of Science (10 credits, mandatory)</td>
<td>Unit 11: Physiology of Human Body Systems (10 credits, optional)</td>
<td></td>
</tr>
<tr>
<td>Unit 4: Scientific Practical Techniques (10 credits, mandatory)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Year 2</th>
<th>Term 4</th>
<th>Term 5</th>
<th>Term 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 2: Working in the Science Industry (10 credits, mandatory)</td>
<td>Unit 15: Microbiological Techniques (10 credits, optional)</td>
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<td></td>
</tr>
<tr>
<td>Unit 20: Medical Physics Techniques (10 credits, optional)</td>
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</tbody>
</table>

Note: It is permissible to integrate some of the optional units with Unit 1 at the outset of this course if the programme team wishes to do so.
### BTEC Level 3 National Diploma in Applied Science:

Six mandatory units plus optional units that provide for a combined total of 120 credits.

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Term 1</strong></td>
<td><strong>Term 2</strong></td>
<td><strong>Term 3</strong></td>
</tr>
<tr>
<td>Unit 1: Fundamentals of Science (10 credits, mandatory)</td>
<td>Unit 1: Fundamentals of Science (cont.) (10 credits, mandatory)</td>
<td>Unit 2: Working in the Science Industry (10 credits, mandatory)</td>
</tr>
<tr>
<td>Unit 4: Scientific Practical Techniques (10 credits, mandatory)</td>
<td>Unit 4: Scientific Practical Techniques (cont.) (10 credits, mandatory)</td>
<td>Unit 13: Biochemistry and Biochemical Techniques (10 credits, optional)</td>
</tr>
<tr>
<td>Unit 6: Using Mathematical Tools in Science (5 credits, mandatory)</td>
<td>Unit 8: Using Statistics in Science (5 credits, optional)</td>
<td></td>
</tr>
<tr>
<td>Unit 43: Diseases and Infections (10 credits, optional)</td>
<td>Unit 18: Genetics and Genetic Engineering (10 credits, optional)</td>
<td></td>
</tr>
</tbody>
</table>

### BTEC Level 3 National Extended Diploma in Applied Science (Forensic Science):

Six mandatory units plus optional units that provide for a combined total of 180 credits.

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Term 1</strong></td>
<td><strong>Term 2</strong></td>
<td><strong>Term 3</strong></td>
</tr>
<tr>
<td>Unit 1: Fundamentals of Science (10 credits, mandatory)</td>
<td>Unit 1: Fundamentals of Science (cont.) (10 credits, mandatory)</td>
<td>Unit 2: Working in the Science Industry (10 credits, mandatory)</td>
</tr>
<tr>
<td>Unit 4: Scientific Practical Techniques (10 credits, mandatory)</td>
<td>Unit 4: Scientific Practical Techniques (cont.) (10 credits, mandatory)</td>
<td>Unit 22: Chemical Laboratory Techniques (10 credits, optional)</td>
</tr>
<tr>
<td>Unit 6: Using Mathematical Tools in Science (5 credits, mandatory)</td>
<td>Unit 6: Using Mathematical Tools in Science (5 credits, mandatory)</td>
<td>Unit 34: Criminal Psychology (10 credits, optional)</td>
</tr>
<tr>
<td>Unit 32: Forensic Evidence Collection and Analysis (10 credits, optional)</td>
<td>Unit 33: Forensic Photography (10 credits, optional)</td>
<td>Unit 35: Applications of Forensic Psychology (10 credits, optional)</td>
</tr>
<tr>
<td>Unit 2: Working in the Science Industry (10 credits, mandatory)</td>
<td>Unit 2: Working in the Science Industry (10 credits, mandatory)</td>
<td>Unit 36: Forensic Fire Investigation (10 credits, optional)</td>
</tr>
<tr>
<td>Unit 3: Scientific Investigations (10 credits, mandatory)</td>
<td>Unit 3: Scientific Investigations (10 credits, mandatory)</td>
<td>Unit 38: Applications of Forensic Psychology (10 credits, optional)</td>
</tr>
<tr>
<td>Unit 11: Physiology of Human Body Systems (10 credits, optional)</td>
<td>Unit 18: Genetics and Genetic Engineering (10 credits, optional)</td>
<td>Unit 40: Criminal Investigation in Practice (10 credits, optional)</td>
</tr>
<tr>
<td>Unit 20: Medical Physics Techniques (10 credits, optional)</td>
<td>Unit 31: Criminology (10 credits, optional)</td>
<td></td>
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</tbody>
</table>

### Year 2

<table>
<thead>
<tr>
<th>Term 4</th>
<th>Term 5 and Term 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 5: Perceptions of Science (10 credits, mandatory)</td>
<td>Unit 5: Perceptions of Science (10 credits, mandatory)</td>
</tr>
<tr>
<td>Unit 41: Clinical Psychology (10 credits, optional)</td>
<td>Unit 11: Physiology of Human Body Systems (10 credits, optional)</td>
</tr>
<tr>
<td>Unit 3: Scientific Investigations (10 credits, mandatory)</td>
<td>Unit 20: Medical Physics Techniques (10 credits, optional)</td>
</tr>
<tr>
<td>Unit 11: Physiology of Human Body Systems (10 credits, optional)</td>
<td>Unit 3: Scientific Investigations (10 credits, mandatory)</td>
</tr>
<tr>
<td>Unit 3: Scientific Investigations (10 credits, mandatory)</td>
<td>Unit 11: Physiology of Human Body Systems (10 credits, optional)</td>
</tr>
<tr>
<td>Unit 20: Medical Physics Techniques (10 credits, optional)</td>
<td>Unit 3: Scientific Investigations (10 credits, mandatory)</td>
</tr>
</tbody>
</table>

### Year 3

<table>
<thead>
<tr>
<th>Term 4</th>
<th>Term 5</th>
<th>Term 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 6: Using Mathematical Tools in Science (5 credits, mandatory)</td>
<td>Unit 3: Scientific Investigations (10 credits, mandatory)</td>
<td>Unit 39: Criminal Investigation Procedures (10 credits, optional)</td>
</tr>
<tr>
<td>Unit 43: Diseases and Infections (10 credits, optional)</td>
<td>Unit 18: Genetics and Genetic Engineering (10 credits, optional)</td>
<td>Unit 31: Criminology (10 credits, optional)</td>
</tr>
<tr>
<td>Unit 32: Forensic Evidence Collection and Analysis (10 credits, optional)</td>
<td>Unit 3: Scientific Investigations (10 credits, mandatory)</td>
<td>Unit 36: Forensic Fire Investigation (10 credits, optional)</td>
</tr>
<tr>
<td>Unit 33: Forensic Photography (10 credits, optional)</td>
<td>Unit 3: Scientific Investigations (10 credits, mandatory)</td>
<td>Unit 38: Applications of Forensic Psychology (10 credits, optional)</td>
</tr>
<tr>
<td>Unit 35: Applications of Forensic Psychology (10 credits, optional)</td>
<td>Unit 18: Genetics and Genetic Engineering (10 credits, optional)</td>
<td>Unit 40: Criminal Investigation in Practice (10 credits, optional)</td>
</tr>
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</table>
Keeping track
Whatever decisions you make about your programme delivery, it is important that you carefully map the assessment of criteria across units and keep accurate records to track learner achievement. Tracker sheets like those shown opposite can be constructed easily in Word or Excel. The ones opposite are available on the CD-ROM that is provided with your specification.

Systematically track all of your assignments at grading criterion level so that you build a full and complete achievement record for every learner. This is especially important in differentiated learning or in special circumstances such as illness where all assignments may not be carried out. In these cases, full unit coverage can sometimes be achieved through cross-referencing with other related units; however, evidence provided by learners must fully cover the criteria.

Many centres are making use of virtual learning environments (VLEs) such as Blackboard or Moodle that allow tutors to maintain individual learner sites and keep work electronically. You may decide to give parents access so that they too can check learner progress and achievement. This kind of service will help parents to understand how BTECs are assessed.

Integrated unit delivery
Where unit delivery is integrated, it is important to ensure that all aspects of assessment and grading criteria are covered by your set assignments. Use a tracking sheet to record assessment decisions on the individual assessment and grading criteria within an integrated assignment. This sheet will be very useful for external quality checks.

For example, if the cells and tissue work from Unit 1: Fundamentals of Science and Unit 11: Physiology of Human Body Systems is delivered through an integrated assignment, then it is crucial that your tracking system clearly indicates which criteria from each unit are covered by the assignment, and notes the assignments in which the remaining criteria for each unit will be covered. It is also crucial that assessment decisions are recorded against the criteria for each unit, irrespective of how they have been assessed. That is, achievement of criteria from Unit 1 must not be assumed just because criteria from Unit 11 have been awarded.

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BTEC units: a quick overview

Every BTEC unit is structured in exactly the same way, and this structure has been developed to facilitate your delivery of the course. The notes here give a quick overview. For full details of this structure please see the specification.

Title page
The first page of the specification gives the unit title, the QCF level, the credit value and the guided learning hours (GLH)*. It also sets out the unit aim and purpose, the unit introduction and the learning outcomes.

* Guided learning hours (GLH) are all the times when a member of staff (such as a tutor, trainer or facilitator) is present to give guidance

Unit content
Lists the breadth of knowledge, skills and understanding needed to achieve each of the learning outcomes. This outlines what you should cover in your delivery and what your learners need to know.

Assessment and grading criteria grid
The evidence that each learner must produce to achieve pass, merit or distinction. This is the most important section of each unit – units must be taught and assessed by these criteria (not the learning outcomes).

Essential guidance for tutors
Unit specific guidance on delivery and assessment.

Outline learning plan
This suggests one way you could deliver the unit. Design your own learning plan to mirror your preferred delivery and assessment methods for unit coverage. (This will be crucial where a more integrated delivery profile is adopted.)

Links to National Occupational Standards, other BTEC units and BTEC qualifications
Shows opportunities for integrated delivery of units.

Programme of suggested assignments
For guidance only, this table lists ideas for assignments that would cover the grading criteria. It is recommended that you write your own assignments or adapt Edexcel’s to meet local needs and resources. Remember: all assignments must be internally verified by your centre before issue to learners to ensure they are fit for purpose.

Essential resources
Specialist resources needed to allow learners to generate evidence for the unit.

Indicative reading, resource packs and websites
Suggested learner resource material.

Functional skills signposting
Opportunities to generate evidence to meet the requirements of functional skills tests.

PLTS signposting
Opportunities to develop personal learning and thinking skills within the unit.
Developing a scheme of work

All BTEC Level 3 National units are structured in a way that should facilitate your delivery of the course. Each unit includes an outline learning plan. This is provided as an example only to illustrate just one way you might deliver that unit. This plan includes suggested assignments that will cover the unit’s grading criteria.

From this outline learning plan you might then develop a more detailed scheme of work. To show how this might be done, the outline learning plan opposite is taken from Unit 1: Fundamentals of Science. On pages 32–40 there is an example of a scheme of work for this unit, which shows you how one might be developed from the other.

Design your own scheme of work to factor in the needs of your learners and local resources, and to reflect the assignments that you have designed. (Always ensure that assignments – whether designed by yourself, Edexcel or others – are internally verified in your centre before use; see page 48.)

Delivery notes
The introductory session could be delivered using practical activities. For example, when explaining what constitutes appropriate evidence for an assignment, learners could work in groups to identify the various methods appropriate evidence for an assignment, learners could work in groups to identify the various methods.

Try to maximize hands-on learning opportunities. You can use practical activities as a way of reviewing learner knowledge from Level 2 programmes, such as a ‘who wants to be a periodic table millionaire’ activity (see sample scheme of work on page 33). As another example, a series of practical investigations into the different types of energy may be an effective way of delivering an introduction to the content on energy.

Looking out for plagiarism
Be careful with the use of the internet, as unfortunately the copying and pasting of text into assignments is happening with alarming regularity. Even at this level, a plagiarism policy may be required to encourage learners to reference the work of others as far as possible. Please see www.jcq.org.uk for advice on detecting plagiarism. On the first (written) assignment make sure that any cut and paste evidence is rejected and that learners are made to do the work in their own words. This will pay dividends in the long run.

How do I cover the content?
- Work closely with the specification document to ensure that you fully understand the coverage for each learning outcome within each unit.
- Check your content coverage against the grading criteria.
- Make sure you understand the distinction between content that must be covered and content that is optional, such as topics listed after the words ‘eg’ in the specification – here tutors may use these examples or replace them with relevant alternatives of their own choice.
- Rather than follow the assignment ideas in the specification, it may be possible for you to consider smaller assignments over shorter periods of time that will keep your learners engaged. Remember that your assignments must always be designed for your learners.
- You should consider more focused assignments that allow greater and more interesting content coverage, rather than trying to squeeze content into assignments inappropriately.
- Use a matrix tracker to plan your assignments and cross-check to see if all content is covered. See page 27 for examples of tracker sheets.

Outline learning plan for Unit 1: Fundamentals of Science

<table>
<thead>
<tr>
<th>Topic and suggested assignments and activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to unit – concept of looking at theory and then related practical work. Health and safety implications.</td>
</tr>
<tr>
<td>Tutor introduction to a review of the periodic table, atomic structure and bonding using computer software programs or worksheets.</td>
</tr>
<tr>
<td>The mole in chemistry, calculating quantities. Formal teaching followed by practice exercises.</td>
</tr>
<tr>
<td>Theoretical input on use of volumetric equipment. Practice preparing standard solutions and carrying out titrations.</td>
</tr>
<tr>
<td>Assignment 1 – Volumetric Analysis Made Easy (P1, P2, M1, D1)</td>
</tr>
<tr>
<td>Assignment 2 – Training for Work (P3, P4, P5, M2, D2)</td>
</tr>
<tr>
<td>Individual learning time plus laboratory practical work. Review of energy types and identification of units used in measurement of each type. Practical demonstrations of energy conversions. Learners research applications of energy transfers, consideration of efficiency. Practice use of calorimeter.</td>
</tr>
<tr>
<td>Assignment 3 – Energy for All (P6, P7, M3, D3)</td>
</tr>
<tr>
<td>Individual learning time plus laboratory practical work. Tutor introduction to the topic. Learner research into methods of communication. Class discussion on suitability of different methods. Preparation of material to produce a scientific poster and carry out a presentation of scientific information – topic to be chosen by learners. Consideration of different purposes and types of audience. What goes where – class or group discussion of the component parts of a scientific report.</td>
</tr>
<tr>
<td>Assignment 4 – Communicating Scientific Information (P8, P9, M4, D4)</td>
</tr>
<tr>
<td>Individual learning time. Review of unit and assessment.</td>
</tr>
</tbody>
</table>

Group work
Group work is vitally important on BTEC programmes and you should provide opportunities frequently throughout the course. At an early stage in the programme, encourage learners to make presentations to other members of the class. These skills will certainly be of benefit in work and in higher vocational programmes. Remember, however, that if any group work contributes towards an assignment, individual learners must be able to provide evidence that they have individually met the criteria.
### Sample scheme of work for Unit 1: Fundamentals of Science

<table>
<thead>
<tr>
<th>Session</th>
<th>Teaching topic</th>
<th>Hours*</th>
<th>Linked assessment</th>
<th>Resource checklist</th>
<th>Core content and delivery methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to BTEC National in Applied Science and Unit 1</td>
<td>1 hour</td>
<td></td>
<td>Handout of unit specification</td>
<td>Tutor overviews unit content and provides a handout showing the unit specification and with a reference to Edexcel’s website. At the start of the programme, explain the pass, merit and distinction criteria and the points scoring in relation to grading.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>A3 (or larger) paper and marker pens for activity on laboratory rules</td>
<td>Tutor presentation to provide an overview of basic health and safety regulations.</td>
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<tr>
<td></td>
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<td></td>
<td>Handout on centre laboratory rules, including code of conduct etc and learner agreements for signature</td>
<td>Small group activity to determine what ‘laboratory rules’ learners think should be operating. Whole group discussion and tutor explanation of rules adopted by the centre. Learners sign individual agreement to follow rules adopted by the centre.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Presentation with slides or video clips of scientists using a variety of practical techniques</td>
<td>Tutor-led discussion on the relationship between theory and practical work.</td>
</tr>
<tr>
<td>2</td>
<td>Review of the periodic table</td>
<td>2 hours</td>
<td>P1</td>
<td>Whiteboard or flipchart for review work</td>
<td>Tutor review of the periodic table from previous learning at GCSE or BTEC First.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Presentation on the periodic table</td>
<td>Tutor presentation on organisation of elements, periodicity, groups (physical and chemical properties), relative atomic mass and atomic number.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Handout: quiz rules and guidance</td>
<td>Small group activity: Who wants to be periodic table millionaire. Learners devising their own questions with which to test other groups.</td>
</tr>
<tr>
<td>3</td>
<td>Review of atomic structure and bonding</td>
<td>2 hours</td>
<td>P1</td>
<td>Whiteboard or flipchart for review work</td>
<td>Tutor review of atomic structure and bonding from previous learning at GCSE or BTEC First.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>Presentation on atomic structure and bonding</td>
<td>Tutor presentation covering Bohr’s theory, ionic and covalent bonding, and the tetrahedral basis of organic chemistry.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>PCs with appropriate software for simulations</td>
<td>Computer simulation showing atomic structure and bonding.</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td>Model kits for pair work</td>
<td>Pair work with learners making models of atomic structures.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Worksheets on different types and examples of bonding</td>
<td>Individual worksheets completed as homework.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Internet and other reference sources for further reading</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Review of moles</td>
<td>2 hours</td>
<td>P1</td>
<td>Presentation on quantities in chemical reactions</td>
<td>Tutor presentation covering balanced equations, relative molecular mass, moles and molalities.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Worksheets with examples and practice calculations</td>
<td>Individual learner work practising calculations.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Whiteboard or flipchart for tutor clarification and explanation</td>
<td></td>
</tr>
</tbody>
</table>

* Guided learning hours (GLH): all times when a member of staff (such as a tutor, trainer or facilitator) is present to give guidance (‘contact time’). This includes lessons, lectures, tutorials and supervised study in, for example, learning resource centres and workshops. It also includes the time staff spend with learners observing and assessing their achievements.
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<tbody>
<tr>
<td>5</td>
<td>Volumetric equipment and analysis</td>
<td>2 hours</td>
<td>P2, M1</td>
<td>Volumetric equipment, including: burettes, volumetric flasks, pipettes, pipette fillers, conical flasks, white tiles. Whiteboard or flipchart for discussion. Standard solutions. Chemicals appropriate for making a range of standard solutions.</td>
<td>Tutor introduction to volumetric equipment and analysis. Whole group discussion of accuracy and tolerances of different equipment. Tutor demonstration of preparation of a standard solution.</td>
</tr>
<tr>
<td>6</td>
<td>Preparing standard solutions</td>
<td>2 hours</td>
<td>P2, M1</td>
<td>Volumetric equipment, including: burettes, volumetric flasks, pipettes, pipette fillers, conical flasks, white tiles. Standard solutions. Chemicals appropriate for making a range of standard solutions. Instructions on preparing a standard solution.</td>
<td>Pair work with learners preparing standard solutions, such as standard solutions of sodium carbonate for the standardisation of strong acids; sodium chloride, for the standardisation of silver nitrate; oxalic (oxalic) acid or potassium hydrogen phthalate, for the standardisation of alkaline solutions.</td>
</tr>
<tr>
<td>7</td>
<td>Titrations</td>
<td>2 hours</td>
<td>P2, M1</td>
<td>Volumetric equipment, including: burettes, volumetric flasks, pipettes, pipette fillers, conical flasks, white tiles. Standard solutions. Chemicals appropriate for making a range of standard solutions. Instructions for carrying out titration for learner reference.</td>
<td>Tutor demonstration of titration in conjunction with pair work. Pair work with learners practising different titrations, such as acid base titrations using the standard solution of sodium carbonate or potassium hydrogen phthalate prepared in the previous session, and a redox titration using potassium permanganate. Tutor guiding and advising during experiments.</td>
</tr>
<tr>
<td>8</td>
<td>Industrial uses of titration (site visit)</td>
<td>2 hours</td>
<td>D1</td>
<td>Off-site visit. Health and safety consent forms. Observation questionnaire. Clipboards for note-taking.</td>
<td>Tour by a company representative. Tutor ‘interviewing’ representative, with a question and answer session. Learners to complete an observation questionnaire and to take notes during the visit. They should ensure that notes are recorded appropriately for later use.</td>
</tr>
<tr>
<td>9</td>
<td>Assignment 1: Volumetric analysis made easy – practical work</td>
<td>3 hours</td>
<td>P1, P2</td>
<td>Assignment 1 brief. Worksheets or other assessment tools. Volumetric equipment, including: burettes, volumetric flasks, pipettes, pipette fillers, conical flasks, white tiles. Standard solutions. Chemicals appropriate for making a range of standard solutions.</td>
<td>Brief learners on assignment on volumetric analysis, including an explanation of pass, merit and distinction criteria. Practical component: individual completion of tasks.</td>
</tr>
<tr>
<td>10</td>
<td>Assignment 1: Volumetric analysis made easy – written work</td>
<td>2 hours</td>
<td>M1, D1</td>
<td>Worksheets or other assessment tools. PCs with appropriate software for producing learner work (such as PowerPoint).</td>
<td>Recap brief. Written component: individual research and completion of tasks.</td>
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<tr>
<td>11</td>
<td>Assignment 1 feedback</td>
<td>1 hour</td>
<td>P1, P2, M1, D1</td>
<td>Assessed assignments and feedback sheets.</td>
<td>Assessment feedback. Tutor to provide individual feedback and discussion. Learners to work on agreed improvements to the assignment.</td>
</tr>
<tr>
<td>12</td>
<td>Use of microscopes</td>
<td>2 hours</td>
<td>P3, P4</td>
<td>Presentation on microscopes Whiteboard or flipchart for the question and answer session Compound light microscopes Electron micrographs Pre-prepared slides of cells</td>
<td>Tutor led review of use of microscopes. Whole group question and answer session on the difference between light and electron microscopes. Working individually, learners practise using light microscope, including the preparation of slides, observation, and drawing techniques, and using electron micrographs.</td>
</tr>
<tr>
<td>13</td>
<td>Cell structures</td>
<td>2 hours</td>
<td>P3, P4, P5, M2, D2</td>
<td>Presentation on microscopic structures Compound light microscopes Electron micrographs Pre-prepared slides of cells</td>
<td>Tutor presentation on microscopic structures of cells, including prokaryote (bacteria) and eukaryote (plants, animals). Learners practise how to draw and label from slides that show cell structure. Individual learner work using worksheets on how different cell components influence function of tissues, and comparing different tissues.</td>
</tr>
<tr>
<td>14</td>
<td>Cells and tissues</td>
<td>2 hours</td>
<td>P3, P4, P5, M2, D2</td>
<td>Presentation on tissues Compound light microscopes Electron micrographs Pre-prepared slides with samples of various epithelial, connective, nerve and muscle tissues</td>
<td>Tutor presentation on tissues, including different types and functions (epithelial, connective, nerve, muscular). Learners to practise how to draw and label from slides that show different types of tissue. Individual learner work using worksheets with questions comparing different types of tissue.</td>
</tr>
<tr>
<td>15</td>
<td>Organelle structure and function</td>
<td>2 hours</td>
<td>P3, P4, P5, M2, D2</td>
<td>Handout: stimulus questions to guide research and list of websites for internet research Internet access and other reference sources for research Overhead projector and transparencies PC with appropriate software (such as PowerPoint) and projector Whiteboard or flipchart for discussion</td>
<td>Individual learner research into organelle structure and function using stimulus questions. Stimulus questions should guide learners to access core content on cell membrane, cell wall, nucleus, nucleolus, cytoplasm, mitochondria, ribosome, endoplasmic reticulum (smooth and rough), Golgi body, lysosome and vesicles. Small group discussion, preparation and presentation of results of research. Tutor clarification, expansion and summary.</td>
</tr>
<tr>
<td>16</td>
<td>Assignment 2: Training for work – practical work</td>
<td>2 hours</td>
<td>P3, P4, P5, M2, D2</td>
<td>Assignment 2 brief Worksheets or other assessment tools Compound light microscopes Electron micrographs Pre-prepared slides and electron micrographs of prokaryotic and eukaryotic cells and various epithelial, connective, nerve and muscle tissues</td>
<td>Brief learners on assignment 2, including an explanation of pass, merit and distinction criteria. Practical component: individual completion of tasks.</td>
</tr>
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</table>
| 17      | Assignment 2: Training for work – written work | 2 hours | P3, P4, P5, M2, D2 | Assignment 2 brief  
Handout: unit specification  
Worksheets or other assessment tools  
PCs with appropriate software for producing learner work (such as PowerPoint) | Recap brief.  
Written component: individual research and completion of tasks. |
| 18      | Assignment 2 feedback | 1 hour | P3, P4, P5, M2, D2 | Assessed assignments and feedback sheets | Assessment feedback. Tutor to provide individual feedback and discussion.  
Learners to work on agreed improvements to the assignment. |
| 19      | Types of energy | 2 hours | P6 | Whiteboard or flipchart for review work  
Practical equipment appropriate to investigations selected, such as two stands, cord and two pendulums, springs, battery-powered cars and balls; bread and peanuts, small copper cans and thermometers; electric motors | Tutor-led review of energy types and units used in measurement.  
Pair work with learners investigating potential, kinetic, chemical, thermal and electrical energy. |
| 20-21   | Energy transformations | 2 x 2 hours | P6, M3 | Presentation explaining energy transformations  
Handouts with directions for each investigation  
Equipment appropriate for investigations of each of these different energy transformations, such as model steam engine, clamp, fuel, pulley, load, drive belt, motor unit and lamp unit; two stands, cord and two pendulums; rocket; hand-driven dynamo and lamp | Tutor explanation of energy transformations, including metabolism, potential to kinetic, generation of electrical energy, thermal energy from fuels, and nuclear energy to electrical energy.  
Pair work (over the course of two sessions) on practical investigations into each of these different energy transformations.  
Tutor supplies guidance. |
| 22-23   | Measurement of energy and energy efficiency | 2 x 2 hours | P7, M3, D3 | Appropriate equipment for demonstrating use of a calorimeter to measure calorific value of different fuels and to measure the efficiency of an energy conversion system  
Calorimeter  
Metal cans, thermometers, spirit burners, different fuels such as alcohols or different types of food  
Whiteboard or flipchart for step-by-step demonstration of calculation  
Handouts: worksheet with calculations and directions for investigation  
Internet access and other reference sources for research | Tutor demonstration of calorimeter and explanation of how to calculate efficiency.  
Individual learner work practising calculations. Par work with learners investigating calorific value of different fuels.  
Learner research on applications of energy conversion and consideration of efficiency.  
Tutor demonstration of use of a calorimeter to measure the efficiency of an energy conversion system.  
Whole group discussion of considerations of efficiency.  
Pair work practising use of a calorimeter to measure the efficiency of an energy conversion system. |
| 24      | Assignment 3: Energy for all – practical work | 3 hours | P6, P7, M3, D3 | Assignment 3 brief  
Worksheets or other assessment tools  
Metal cans, thermometers, spirit burners, different types of alcohol | Brief learners on assignment 3, including an explanation of pass, merit and distinction criteria.  
Practical component: individual investigation of the calorific value of different fuels. |

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<tbody>
<tr>
<td>25</td>
<td>Assignment 3: Energy for all – written work</td>
<td>2 hours</td>
<td>P6, P7, M3, D3</td>
<td>Assignment 3 brief</td>
<td>Recap brief. Written component: individual research and completion of tasks.</td>
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<td></td>
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<td>Handout: unit specification</td>
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<td></td>
<td>Worksheets or other assessment tools</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PCs with appropriate software for producing learner work (such as PowerPoint)</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Assignment 3 feedback</td>
<td>1 hour</td>
<td>P6, P7, M3, D3</td>
<td>Assessed assignments and feedback sheets</td>
<td>Assessment feedback. Tutor to provide individual feedback and discussion. Learners to work on agreed improvements to the assignment.</td>
</tr>
<tr>
<td>27</td>
<td>Methods of communication</td>
<td>2 hours</td>
<td>P8, P9, M4, D4</td>
<td>Presentation on communicating scientific information</td>
<td>Tutor introduction to how scientific information is communicated. Tutor-led discussion on the appropriateness of different methods of communication for different purposes. Whole group discussion analysing examples of detailed, correctly structured reports from professional journals.</td>
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<td>Whiteboard or flipchart for discussion</td>
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<td></td>
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<td></td>
<td>Handouts: examples of scientific reports from journals</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Scientific report writing</td>
<td>2 hours</td>
<td>P8, P9, M4, D4</td>
<td>Large poster paper</td>
<td>Tutor explanation of activity. Practical activity in pairs, with learners preparing material on a topic of their choice for a poster presenting scientific information to the general public. Short presentation of posters. Tutor review of the elements of a scientific report and how they are arranged and presented, including title, abstract, introduction, method, results, discussion, conclusions, references and bibliography.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Scissors</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Coloured pens and pencils</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Industry journals and magazines</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Internet and other reference sources for research</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Assignment 4: Communicating scientific information</td>
<td>3 hours</td>
<td>P8, P9, M4, D4</td>
<td>Assignment 4 brief</td>
<td>Learners to produce a written report from one of their own practical investigations.</td>
</tr>
<tr>
<td>30</td>
<td>Assignment 4 feedback</td>
<td>1 hour</td>
<td>P8, P9, M4, D4</td>
<td>Assessed assignments and feedback sheets.</td>
<td>Assessment feedback. Tutor to provide individual feedback and discussion. Learners to work on agreed improvements to the assignment.</td>
</tr>
<tr>
<td>31</td>
<td>Unit review</td>
<td>2 hours</td>
<td>End-of-unit questionnaires</td>
<td>Review and evaluation of unit. Final awarding of marks. Learner feedback and end-of-unit questionnaires. Feedback.</td>
<td></td>
</tr>
</tbody>
</table>

* Guided learning hours (GLH): all times when a member of staff (such as a tutor, trainer or facilitator) is present to give guidance (‘contact time’). This includes lessons, lectures, tutorials and supervised study in, for example, learning resource centres and workshops. It also includes the time staff spend with learners observing and assessing their achievements.
Assessment and grading

Learners work through BTEC units by participating in the learning programme and tackling the assignments you set for them. The ultimate aims in the setting of assignments are to cover the grading criteria for each unit and to set learning within a vocational context. (Full guidance on assignment design can be found on page 44.)

Tell me more about assignments

The number of assignments for each unit will vary. It is up to you how you decide to cover the grading criteria for each unit. Take into account the ability of your cohort of learners, the requirements of the unit itself, local resources and, not least, your imagination as tutor.

There are drawbacks in setting too few and too many assignments. If you set too few assignments (by, say, adopting the one-off project approach), you can place too much reliance on large pieces of evidence that may only be available late in the programme. These large assignments can be hard to assess and difficult to put right if things go wrong.

Too many assignments can put a burden on both you and your learners. This can lead to fragmentation of the unit. The unit content, outcomes and grading criteria have generally been produced to provide a coherent package. As such, the assignments should, wherever possible, maintain the coherence and links between the outcomes and grading criteria of the unit.

Your delivery can be through differently paced assignments, with some to be completed in a short space of time and others over a half or whole term. Take advantage of recent news items or events, particularly those that reflect local interest. These can provide useful points of entry into coverage of unit content and the assessment of specific unit criteria.

Remember that assignments must be internally verified before issue.

It is good practice to provide learners with a list of assignment deadlines over the period of study. This will help learners to manage their workload. The table below shows part of an example assignment plan (the table could be extended to cover two years).

<table>
<thead>
<tr>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>January</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1</td>
<td>Assignment 1</td>
<td>Assignment 2</td>
<td>Assignment 7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Assignment 4</td>
<td>Assignment 3</td>
<td>Assignment 6</td>
<td></td>
</tr>
<tr>
<td>Unit 4</td>
<td>Assignment 5</td>
<td>Assignment 5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Kick-starting an assignment

Successful assignments can be sparked off by events in the news or trips out of the classroom or laboratory, such as a visit to a science museum or scientific display, but even excursions into the locality to investigate how science is used in everyday activities can be good starting points. (Your teaching programme should always lead learners into each assignment.)

Building a portfolio of evidence

Encourage your learners to compile a portfolio of evidence to meet the assessment and grading criteria for each unit. It is important that learners have the opportunity early on in the course to develop portfolio-building skills, so that they can manage and organise their evidence. Results from practical investigations, notes from research, reference lists, notes on standard operating procedures, health and safety issues related to relevant materials, techniques and processes, and mathematical and statistical techniques all contribute to profile an individual’s learning.

What about grading?

Learners need to provide evidence to meet the grading criteria shown in the unit specification.

- To pass a unit, every pass criterion needs to be achieved.
- To gain a merit, all the pass and merit criteria need to be achieved.
- To gain a distinction, all the pass, merit and distinction criteria need to be achieved.

See the specification for information on how unit grades are converted to points to calculate an overall grade for their course. Learners who complete the unit but who do not meet all the pass criteria are graded ‘unclassified’.

Each criticism generally begins with an operative verb, for example:

- Pass = describe (what)
- Merit = explain (how)
- Distinction = justify/evaluate (why)

It is crucial that these same operative verbs are used in the wording of assignment tasks to yield correct evidence from the learner to meet each criterion.

Each assignment must cover part or all of the grading criteria in the unit’s assessment and grading grid. This will be dependent on the nature and size of the individual assignment, and how it relates to the content of the unit (or units, if you are integrating unit delivery through assignments).

The grading grid in Unit 1 has nine pass, four merit and four distinction grading criteria. Assignments can group criteria in any reasonable cluster but P1, P2, M1 and D1 naturally fit together, as do P3, P4, P5, M2 and D2; P6, P7, M3 and D3; and P8, P9, M4 and D4. It is at your discretion to decide how to cover the criteria within the assignments. Careful consideration should be given to whether to address merit and distinction criteria in the early stages of a course or to include them in later assignments once you are satisfied that the building blocks of understanding and application have been achieved. You will need to ensure that learners have sufficient time to develop skills before having to perform them for assessment purposes.

It is standard practice to introduce a vocational scenario into each assignment. This will indicate to learners how the information or techniques that are covered by the assignment are used in the real world.

When the criteria include the assessment of skills or knowledge and understanding that cannot always be evidenced in writing, the use of observation sheets or witness statements is advised – preferably with the unit criteria printed out so that accurate judgements can be made against these criteria. All documents of this nature should be signed and dated to form an authentic audit trail within the learner’s assessment profile. For more information about the use of observation and witness statements see page 45.

Working towards merit and distinction

As the programme progresses you will find that some learners struggle to achieve the merit and distinction criteria. This is normal for learners studying at this level, as the merit and distinction grading criteria have been devised for those learners who are capable of higher thinking skills. It is normal for very few learners to achieve a distinction. It is imperative, however, that in giving feedback on assignment work you clearly show learners what they need to do to improve to achieve the merit and distinction criteria.

Tracking learner achievement

There is an example of a tracking grid on page 27. These types of grid enable you to keep a record of learners’ progress during the course. If your unit delivery is integrated with other units, the grids facilitate your tracking of which assignments have covered which grading criteria.

It is important that assessors, internal verifiers and external verifiers have easy access to learner evidence for each of the unit grading criteria. The evidence must be clearly referenced and annotated in each learner’s portfolio.

For full information on grading, see the specification.
Assignment design

Assignments must be designed to motivate learners and to allow learners to achieve specified unit grading criteria in vocational contexts, and must call on learners to produce varied forms of evidence.

When designing assignments it is possible to:

• have one assignment brief to assess all the grading criteria of a unit
• have two or more smaller assignment briefs for a unit
• allow assessment criteria from one unit to be integrated with assessment criteria from another unit.

The assignment brief must include:

• the title and level of the qualification
• the title and number of units under assessment
• the title of the assignment
• the dates the assignment is set (start date)
• submission/assessment dates
• the name of the assessors
• the name of the learner
• space for the learner to sign to confirm the work is their own.

In addition to this the use of interim/milestone assessment dates is recommended – especially where assignments cover a number of criteria. It is essential that assignments have a suitable timescale.

The scenario

The assignment should be based within an interesting vocational scenario so that learning can be applied to the real world of work.

The tasks

Each assignment is divided into tasks; detailed descriptions of the activities learners will undertake in order to produce evidence to meet the unit’s grading criteria and complete the assignment. Each task must:

• specify the extent and nature of evidence that learners should present
• be clear, specific, time-bound, stepped, relevant and realistic
• address the grading criteria they target, paying careful attention to the operative verb of each criterion (‘describe’, ‘explain’, ‘evaluate’ etc)
• reference the grading criteria they address
• be presented in learner-friendly, engaging and inspirational language; they should not simply repeat the grading criteria
• address the grading criteria in full, and not split a criterion across more than one assignment.

Evidence

Clearly state what learners are expected to provide as evidence for each task. Be specific about the kinds of evidence that learners must present, the format of that evidence, and set word limits to provide some indication of what is expected. This should be articulated as a minimum requirement for attainment, so that you don’t inadvertently create barriers to achievement in the process. Also state the resources that will be available to learners, laboratory access times, and whether there will be additional opportunities to access facilities to learn the required techniques or to complete the assignment. Forms of evidence include:

• recorded discussions
• log books and diaries
• artefacts
• presentations
• performance
• role plays
• brochures, leaflets, posters and promotional materials
• case studies
• web-based material (websites, blogs, VLE, podcasts etc)
• reports and written investigations
• annotated photographs
• work-based evidence.

Assessment and grading criteria

• The assignment must state exactly which assessment criteria are being addressed.
• Centres must not rewrite any aspect of the unit’s assessment and grading criteria nor add their own centre-devised criteria.
• Centres may provide additional guidance, explaining assessment criteria requirements in learner-friendly language, but the exact wording of the published criteria must appear on the assignment.
• An assignment can have one unit as the main focus, but learners may also be producing evidence towards other units as well.

Local needs

Assignment briefs should always be developed and adapted to meet the needs of learners at your centre and to take account of your centre’s resources. They must also be checked by someone in your centre (internally verified) to ensure they are fit for purpose before they are given to learners (for more information on this see page 48).

The assignment brief will often need to be supplemented with further information, for example:

• a demonstration
• handouts
• videos or DVDs
• references to books
• references to websites
• visits to science organisations and museums
• talks by guest speakers and local practitioners.

An example of an assignment brief can be found on pages 56–57.

Engage your learners

The most successful assignments will engage and excite learners to take responsibility for the progress of their own learning.

Learner responsibility

Learners need to take responsibility for completing their assignments. Many centres have instigated learner agreements or contracts which learners sign to commit themselves to meeting all deadlines and to the other demands of completing their programme.

Learners need to produce assessment evidence that is all their own work – plagiarism can be an issue. It is important that learners are instructed on the correct use of referencing. For more information, see Edexcel’s Centre Guide to Managing Quality: Policies, Procedures and Practice.

Observation records

An observation record is used to provide a formal record of an assessor’s judgement of learner performance (for example, during presentations, practical activity, performance, role play) against the targeted grading criteria. The record:

• will relate directly to the grading criteria in the unit
• may confirm achievement or provide specific feedback of performance
• will provide primary evidence of performance
• will be sufficiently detailed to enable others to make a judgement as to quality and whether there is sufficient evidence of performance.

Observation records should be accompanied by supporting additional evidence. This may take the form of visual aids, video or audio tapes, CDs, photographs, handouts, preparation notes, cue cards, diary records, log books and/or peer assessment records. Observation records should also:

• note how effectively these were used to meet the assessment criteria
• record the assessor’s comments
• be evidenced in a learner’s portfolio when assessment is carried out through observation, together with relevant supporting evidence
• be completed by the assessor, who must have direct knowledge of the specification to enable an assessment decision to be made
• be signed and dated by the assessor and the learner
• also include the learner’s comments.

An observation record can have greater validity than a witness statement since it is capable of directly recording an assessment decision without reference to others.

Witness statements

A witness statement is used to provide a written record of what is expected of a learner in a particular assessment (for example, laboratory test evidence) against grading criteria. Someone other than the assessor of the qualification/unit may complete it. This may be an assessor of a different qualification or unit, a work placement supervisor, a technician, a learning resources manager or anyone else who has witnessed the performance of the learner against given assessment criteria. It can be someone who does not have direct knowledge of the observation, but who has seen the learner perform the activity. It is a whole who is able to make a professional judgement about the performance of the learner in the given situation.

The quality of a witness statement is greatly improved, and enables the assessor to judge the standard and validity of performance against the assessment criteria, if:

• the witness is provided with clear guidance on the desirable characteristics required for successful performance by including a checklist
• the grading criteria are present on the witness testimony (this may need further amplification for a non-assessor)
• the learner or witness also provides a statement of the context within which the evidence is set.

The witness statement does not confer an assessment decision. The assessor must:

• consider all the information in the witness statement
• note the relevant professional skills of the witness to maintain a judgement of performance
• review and support evidence when making an assessment decision
• review the statement with the learner to enable a greater degree of confidence in the evidence
• be convinced that the evidence presented by the witness statement is valid, sufficient and authentic.

When a number of witnesses are providing testimonies:

• every witness testimony should be signed and dated by the witness
• information of their job role/relationship with the learner should also be available.

These details add to the validity and authenticity of the testimony and the statements made in it. Centres should note that witness testimonies can form a vital part of the evidence for a unit(s) but they should not form the main or majority assessment of the unit(s).

Example forms for observation records and witness statements are given on pages 46 and 47 and can be modified to show a centre’s own logo. They are available in Word on the CD-ROM in your Specification Pack.
## Observation record (by tutor)

<table>
<thead>
<tr>
<th>Learner name</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualification</td>
<td></td>
</tr>
<tr>
<td>Unit number and title</td>
<td></td>
</tr>
</tbody>
</table>

**Description of activity undertaken (please be as specific as possible)**

<table>
<thead>
<tr>
<th>Assessment and grading criteria</th>
<th></th>
</tr>
</thead>
</table>

**How the activity meets the requirements of the assessment and grading criteria**

<table>
<thead>
<tr>
<th>Learner signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessor signature</td>
<td>Date</td>
</tr>
<tr>
<td>Assessor name</td>
<td></td>
</tr>
</tbody>
</table>

## Witness statement (by external observer)

<table>
<thead>
<tr>
<th>Learner name</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualification</td>
<td></td>
</tr>
<tr>
<td>Unit number and title</td>
<td></td>
</tr>
</tbody>
</table>

**Description of activity undertaken (please be as specific as possible)**

<table>
<thead>
<tr>
<th>Assessment and grading criteria</th>
<th></th>
</tr>
</thead>
</table>

**How the activity meets the requirements of the assessment and grading criteria, including how and where the activity took place**

<table>
<thead>
<tr>
<th>Witness name</th>
<th>Job role</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Witness signature</td>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>Learner signature</td>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>Assessor name</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assessor signature</td>
<td>Date</td>
<td></td>
</tr>
</tbody>
</table>
**Internal verification of assignment briefs**

Internal verification is a quality assurance system you must use to monitor assessment practice and decisions. It is there to ensure that:

- assessment and grading are consistent across the programme
- assignments are fit for purpose
- assessment decisions accurately match learner work (evidence) to the unit grading criteria
- standardisation is a feature of centre assessment practice.

All assignments must be internally verified before they are issued to learners. The internal verification should be done by a tutor who is vocationally competent and who understands the specialist nature of the BTEC Level 3 National in Applied Science units. This is to ensure that:

- the tasks and evidence will allow the learner to address the targeted criteria
- the assignment is designed using clear and accessible language
- learners’ roles and tasks are vocationally relevant and appropriate to the level of the qualification
- equal opportunities are incorporated.

The system used to do this is a matter for individual centres. Edexcel fully supports the use of the centre’s own quality assurance systems where they ensure robust internal standardisation.

Internal verification of assignment briefs should always be reported and recorded. If action is required, the assessor should complete this and return it to the internal verifier for sign-off. Once the assignment is verified as fit for purpose, it may be issued to the learners.

Internal verifiers are advised to use the paperwork that is available on the CD-ROM that accompanies the Specification Pack (see the example on page 58) as this meets all Edexcel requirements.

Internal verification is to be seen as a supportive process. If an assignment brief is not fit for purpose, the internal verifier should return the assignment with appropriate comments. There should be a deadline set for the amendments to be made and, when all is approved, the documents should be signed and dated to give the team an auditable document. Tutors can engage in professional discussions where there is disagreement so that all standards and decisions are shared and understood.

**Lead internal verifiers**

Each group of programmes has a lead internal verifier who coordinates the work of other internal verifiers and offers leadership on issues of internal standardisation and related training. The lead internal verifier will be expected to gain accreditation via the Edexcel online OSCA2 test. The achievement of this test will permit release and certification of learner attainment. For more information on becoming a lead internal verifier, see [www.btec.co.uk](http://www.btec.co.uk).

(Some programmes may be subject to annual sampling prior to release of certification of learner attainment.)

For an example of an internal verification form for assignment brief, see page 58.

**Procedure for internal verification**

1. Identify the tutors (assessors) and internal verifier team for the whole programme.
2. Tutor uses a tracking sheet (see page 27) to produce a teaching and learning schedule for each unit or set of integrated units.
3. Internal verifier samples ALL assignment briefs prior to issue to learners.
4. Tutor briefs learners on assignments and explains grading criteria.
5. Tutor grades assignments and provides written feedback.
6. Sample of grades submitted to the internal verifier.
7. Correct assessment is signed off and grading decisions are released to learners.
8. Internal verifier samples actual assessments to check use of grading criteria and veracity/authenticity of learner evidence – viva, presentation, demonstration etc.
9. Incorrect assessment decisions are returned to tutor to be revised within a timeframe and clear guidelines.
10. Unacceptable assignments are returned to tutors with full commentary, an action plan and time frame for resubmission.
11. Internal verifier samples assignment briefs to ensure they are fit for purpose.
12. Lead internal verifiers each group of programmes has a lead internal verifier who coordinates the work of other internal verifiers and offers leadership on issues of internal standardisation and related training.
Grading an assignment

When designing an assignment it is key that you set the level of expectation for learners and provide guidance related to the kinds of evidence that should be producing. Assignments will not, ideally, require a uniform response, otherwise you will have difficulty in assessing across the range of grading criteria – differentiated learning would be constrained. Learners should have the freedom to develop their own responses within the demands of the learning outcomes and grading criteria.

When grading an assignment it is good practice to use a form such as that shown on page 79 (this is available on the CD-ROM in your Specification Pack). Alternatively, you can devise your own assessment record sheets, but these should always allow space for feedback to learners on their performance against the criteria. It is also good practice to have space for learners to comment on their own work. It is important to give learners positive feedback that tracks and records their learning journey and achievement but also identifies areas for improvement. This is very valuable for learners who have missed criteria and need further encouragement and direction to achieve these criteria.

Learners normally receive feedback after each assignment has been assessed and internally verified.

Key points

- Always use the specification document and cross-reference learner evidence to the learning outcomes, unit content and the unit's assessment and grading grid to ensure that the criteria specified in the assignment are fully met. For merit and distinction grades, the decisions should not be based on the quantity of evidence presented but on its quality (in meeting the grading criteria).
- The guidance section of each unit specification will assist you in reaching a decision. Delivery teams will find that standardisation prior to major unit assessment will be very useful in setting the standard of individual assessors' decisions. Use of a sample of learner work across the grade boundaries, especially if there are 'cusp' decisions, is the best way of setting the team standard. This activity builds confidence among the assessor team. A post-standardisation session can be very useful for further discussions on the quality and standard of the work that has been assessed, and it provides an opportunity for internal verification to take place before grading decisions are confirmed to learners.
- Good feedback can identify the way that learners can achieve a higher grade and positive feedback will assist learners who may be diffident about gaining more than a pass grade, which is a common problem with learners who are only prepared to do the bare minimum to pass. Assessors can encourage learner self-esteem and confidence by setting clear expectations. The feedback section can also provide learners with an individual learning plan, giving clear targets for completion, dates and deadlines.

Maximising learner achievement

Unit grades need not be submitted to Edexcel until the centre wishes to claim certification. Learners should have every opportunity to obtain the best unit grades they are able to achieve.

Learners could be encouraged to tackle criteria that they have missed or areas in which they are weaker in understanding and achieving via newly designed assignments. Mini assignments or a second opportunity to meet the criteria in a fresh way is good educational practice. Newly designed assignment briefs must be internally verified before issue to learners.

Improving grades

In general, BTEC units expect a gradual improvement in grades over the progress of the course as learners become more familiar with the degree of independence and self-responsibility that is required to meet the higher grading criteria.

Internal verification of assessor's comments

Once assignments have been graded, the internal verifier should sample these to ensure that the assessor is:

- conducting assessment in a fair and equitable way
- using the specification document
- using grading criteria
- checking the veracity and authenticity of learner evidence through vivas, presentations, demonstrations etc.

Internal verifiers can give their feedback using a form like the one shown on page 80.

Centre teams can hold standardisation sessions to establish the veracity and accuracy of the team's assessment decisions.

For an example of a graded assignment, see page 79.

For an example of an internal verification form for an assessor's decisions, see page 80.

Any incorrect assessment decisions will be returned to assessors to be revised within a timeframe. Where the internal verifier deems the assessment decisions to be invalid, there must be dialogue between assessor and internal verifier to discuss the issues raised. This dialogue should be documented on the internal verification form together with the action to be taken and the resulting grading outcome. There must be a clear audit trail of the closing of the 'quality loop'.

All activity should be recorded and should take place before final grades are issued to learners.
How many assignments should there be?  
As many as are necessary to assess the unit. Determine the most appropriate assessment strategy for the unit, taking into account the ability of your cohort of learners, the requirements of the unit, local resources and your imagination as tutor.

If you set too few assignments (by, say, adopting the one-off project approach), you can place too much reliance on large pieces of evidence that may only be available late in the programme. These large assignments can be hard to assess and difficult to put right if things go wrong.

Too many assignments put a burden on both you and the learners. This can lead to fragmentation of the unit. The unit content, outcomes and grading criteria have generally been produced to provide a coherent package. As such, the assignments should, wherever possible, maintain the coherence and links between the outcomes and grading criteria of the unit.

When should assignments be set?  
There are two issues here when considering timing. First, be aware of the possibility of assessment overload – when there is a bunching of assignment deadlines across a number of units at any point in the programme. To avoid overload, detailed planning needs to take place at programme level to spread the assessment load. Second, there is the issue of identifying the most appropriate place within the unit for the assignment. This will be determined by a combination of the nature of the unit and the way the outcomes link together plus the overall approach taken to teaching and learning.

As a third consideration, if you are aware of the timing of external quality checks, it is good to prepare for this early in the year by setting some assignments and assembling all learner work. This will take away any pressure on your delivery and assessment.

Can tests be used?  
Any valid method of assessment can be used, and this includes tests in the appropriate place. However, the assessment must be made against the grading criteria set within the unit, and this equally applies to tests as well as any other method. The overriding issue is the need to prepare assessment instruments that are fit for purpose, challenging and vocationally relevant, and that provide a vocational focus that will interest and engage the learner.

What if the work is handed in late?  
Deadlines are an important aspect of any work. In general, time deadlines should be given for the end of the unit. Centres need to inform learners about their policy towards late work. If a learner hands in work late without prior negotiation, then the centre may decline to mark it. If the centre marks the work, then all grades applicable to the unit must be considered. In this case, the learner must not be punished for late work. As these programmes are vocational, some assignments will not permit late submissions, such as those that involve the performance to an audience or production of a newspaper.

How can learners be encouraged to achieve more than just a pass?  
The assignment design, guidance and support are all important factors in getting learners to achieve at the highest possible level. It must be recognised that learners do have choice and, if they make a conscious and informed choice to only achieve at pass level, then there is probably very little anyone can do. However, experience shows that learners who become fully engaged in their BTEC programme – understanding its interim and varied assessment model, the importance of tutorials and the clear recording of grading criteria that they have achieved – will be encouraged and will aim higher.

What if a learner doesn’t achieve a pass?  
Feedback and support should be provided to ensure that the learner is aware of any failings in the work presented for assessment and then given the opportunity to rectify these failings through some means (such as reworking material, taking advantage of a further assessment opportunity etc.). However, if by the end of a unit or course the learner has still not been able to achieve all of the pass criteria, this would be considered ‘completed’ but not ‘achieved/passed’. This assumes that the programme team is satisfied that the learner has attempted the assessment(s) instruments. If the learner has not attempted assessment, then the programme team could indicate that the unit/course has not been completed by the learner, and in such cases the qualification certificate would be withheld.

How many times can a learner rework or resit an assignment?  
The issue here is the validity of the assessment instrument. If a learner is simply going round and round on a single task or activity brief, then the validity of the assessment must come into question and the tutor should consider the need for an alternative assessment instrument.

If the assignment is prompting learning, then that is what the course is about in the first place and therefore rework is to be encouraged wherever applicable.

The final assessment evidence simply needs to be a valid and reliable measure of the learner’s current level of achievement against the outcomes and criteria of the unit.

Improving grades  
Lack of achievement can usually be attributed to poor attendance and the production of inadequate work – or the failure to produce any work – for assessment. Ongoing assessment through teaching tutorials, crits and portfolio reviews using the unit grading criteria can highlight weaknesses in performance. These can be addressed through individual learning plans, which should be set with clear targets for activities and deadline dates for presentation.

Frequently asked questions  

![Example of an assessment plan for two assignments](image)

The first assignment covers the first outcome and has an initial deadline for feedback indicated at A. If this deadline is met, the work is reviewed and detailed feedback provided to learners at B. Learners can then rework the evidence, based on the feedback provided, and resubmit for final assessment at E.

The deadline for feedback on Assignment 2 is C, with feedback at D and final submission for assessment also at E. To encourage learners to meet the deadlines, work submitted after point B will only be assessed and then returned with feedback at D. Learners’ work is only ever double-handled using this process but it does provide learners with an opportunity to reflect on their work and achieve at the highest possible level.

Concerns about the advantages in this system for those learners who take more time to achieve are balanced out by the advantages gained by the informed feedback and, possibly, the removal of the work burden for those who meet deadlines. What this system does achieve is that it encourages learning based on sound assessment decisions.

What if the work is handed in late?  
Deadlines are an important aspect of any work. In general, time deadlines should be given for the end of the unit. Centres need to inform learners about their policy towards late work. If a learner hands in work late without prior negotiation, then the centre may decline to mark it. If the centre marks the work, then all grades applicable to the unit must be considered. In this case, the learner must
All assignments you set for your learners must be internally verified

It is intended that sample assignments are used as examples of good practice. However, they may not be entirely appropriate for every learner in every centre. You are advised to make suitable amendments to sample assignments in response to your own centre’s requirements to meet the needs of your learners. All sample assignments used, whether amended or not, must be internally verified by a suitable person at your centre.

Anyone who is involved with chemistry in any form will need to understand why elements and compounds behave in the way that they do. This behaviour is controlled by an element’s atomic make-up, and this in turn dictates its place in the periodic table. Bonding is an essential part of the information governing how elements join together.

In the workplace, technicians often make solutions for tests, requiring knowledge of chemical equations, moles and molarity for standardisation of other solutions or calibration of equipment. Mixing chemicals can be a hazardous procedure if the processes involved are not well understood.

Although this topic will have been studied at GCSE level, it is worthwhile going over it again to ensure that learners do not have any misunderstandings. Obviously, the degree of reiteration and the amount of information required to fill in any gaps in learner knowledge will vary from group to group. There are several computer-based resources and DVDs giving good animations of the periodic table, chemical properties and bonding. Question sheets could be filled after learners watch these animations.

Resources such as molecular modelling kits and molecular models will give learners a visual conception of the processes involved in bonding. To give learners practical understanding of the concepts involved and also the need for accuracy, get them to prepare their own solutions for titration. It is also essential to provide a clear representation of the periodic table, with examples of the periodicity and how elements are grouped together.

This sample assignment has been devised to allow learners to work through examples and to help them identify patterns being built up in sections, such as in the atomic structure of shells. By the time learners begin the titration, they should feel confident that they have all the background information required to understand what is taking place and to complete the titration successfully.

All learners are different and will approach their assignments in different ways

The sample assignment that follows shows how one learner answered a brief to achieve pass, merit and distinction level criteria. The learner work shows just one way in which grading criteria can be evidenced. There are no standard or set answers. If your assignment is fit for purpose, and if your learners produce the required evidence for each task, then they will achieve the grading criteria covered by the assignment.

Sample assignment front sheet

This front sheet must be completed by the learner where appropriate and included with the work submitted for assessment.

<table>
<thead>
<tr>
<th>Criteria reference</th>
<th>To achieve the criteria the evidence must show that the learner is able to:</th>
<th>Task no.</th>
<th>Page numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>outline the key features of the periodic table, atomic structure and chemical bonding</td>
<td>1</td>
<td>1–7</td>
</tr>
<tr>
<td>P2</td>
<td>demonstrate practically the ability to prepare chemical solutions and test their accuracy</td>
<td>2</td>
<td>8–10</td>
</tr>
<tr>
<td>M1</td>
<td>relate the key features of the periodic table to the conclusions drawn from the practical activities</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>D1</td>
<td>explain how standard solutions and titrations are prepared in industry</td>
<td>4</td>
<td>12–19</td>
</tr>
</tbody>
</table>

Learner declaration

I certify that the work submitted for this assignment is my own and research sources are fully acknowledged.

Learner signature: Jason Evans

Date: 9 December 2010
Sample assignment brief

The purpose of this assignment is to:
allow you to demonstrate your knowledge, skills and understanding of some fundamental concepts in chemistry.

Scenario
You are a new technician working for Chemsol, a chemical company. Chemsol has been approached by Edvisprog, a company that produces visual aids and teaching resources for education. Edvisprog is planning a series of worksheets, handouts and videos of practicals for a web-based set of teaching and learning resources on the use of titrations. The senior technician at Chemsol has asked you to help create a portfolio of material for Edvisprog. Some of this material will draw on worksheets in Chemsol's testing and induction pack.

Task 1
It is planned to include several worksheets in Edvisprog's teaching and learning resource pack. You need to work through and complete some worksheets so that Edvisprog can supply teachers with the correct answers. You have been given five worksheets to complete (see attachment to this brief).

Worksheet 1: Atomic structure
Worksheet 2: The electronic structure, atomic number and mass number of the first twenty elements
Worksheet 3: The electronic structures of the first twenty elements
Worksheet 4: The periodic table
Worksheet 5: Bonding

This provides evidence for P1

Task 2
You must now undertake some practical work which can be recorded for a video for the web-based resource. (In practice, your tutor will observe you completing the practical work in the task.)

The details of the practicals are set out in two worksheets (again provided with this brief). You must conduct the experiments described and complete the necessary calculations as set out in the worksheets.

Worksheet 6: Preparation of a standard solution of sodium carbonate
Worksheet 7: Titration to determine the equation for the reaction between hydrochloric acid and sodium carbonate

This provides evidence for P2

Task 3
In order to consolidate the material presented in the worksheets and practicals, Edvisprog will be publishing some supporting documentation. You have been asked to draft one of these documents. You need to explain how key features of the periodic table relate to the conclusions drawn from the practical work.

This provides evidence for M1

Task 4
It is important that people using the Edvisprog material understand the relevance and importance of titration for industry. So for this final task, you need to draft a further document for the education pack. In this document, you should explain and illustrate how standard solutions are prepared and titrations carried out in industry. Give information on the various methods of carrying out titrations in an industrial environment.

This provides evidence for D1

Sources of information
Websites
A visual interpretation of the table of elements
www.rsc.org/chemsoc/visualelements/index.htm

This brief has been verified as being fit for purpose

Assessor
Mr J Morris
Signature
J Morris
Date
11 October 2010

Internal verifier
Ms A Cooke
Signature
Angela Cooke
Date
11 October 2010
**Sample internal verification of assignment brief**

<table>
<thead>
<tr>
<th>Qualification</th>
<th>BTEC Level 3 National Diploma in Applied Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit</td>
<td>Unit 1: Fundamentals of Science</td>
</tr>
<tr>
<td>Assessor</td>
<td>Mr J Morris</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Internal verifier checklist</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are accurate programme details shown?</td>
<td>Y</td>
</tr>
<tr>
<td>Are accurate unit details shown?</td>
<td>Y</td>
</tr>
<tr>
<td>Are clear deadlines for assessment given?</td>
<td>Y</td>
</tr>
<tr>
<td>Is this assignment for whole or part of a unit?</td>
<td>Y        This is the first of four assignments that cover the unit.</td>
</tr>
<tr>
<td>Are the assessment criteria to be addressed listed?</td>
<td>Y P1, P2, M1, D1</td>
</tr>
<tr>
<td>Does each task show which criteria are being addressed?</td>
<td>Y Yes, these are stated under task headings.</td>
</tr>
<tr>
<td>Are these criteria actually addressed by the tasks?</td>
<td>Y Yes, P1 is Task 1, P2 is Task 2, M1 is Task 3 and D1 is Task 4</td>
</tr>
<tr>
<td>Is it clear what evidence the learner needs to generate?</td>
<td>Y Completed worksheets and written reports</td>
</tr>
<tr>
<td>Are the activities appropriate?</td>
<td>Y These are good activities allowing learners to undertake research.</td>
</tr>
<tr>
<td>Is there a scenario or vocational context?</td>
<td>Y The learner is a new employee.</td>
</tr>
<tr>
<td>Are the language and presentation appropriate?</td>
<td>Y The language and presentation are appropriate.</td>
</tr>
<tr>
<td>Is the timescale for the assignment appropriate?</td>
<td>Y Learners have four weeks to complete. This is an appropriate timescale.</td>
</tr>
<tr>
<td>Overall is the assignment fit for purpose?</td>
<td>Y</td>
</tr>
</tbody>
</table>

* If "No" is recorded and the internal verifier recommends remedial action before the brief is issued, the assessor and the internal verifier should confirm that the action has been undertaken.

<table>
<thead>
<tr>
<th>Internal verifier</th>
<th>Ms A Cooke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signature</td>
<td>Angela Cooke</td>
</tr>
<tr>
<td>Date</td>
<td>7 October 2010</td>
</tr>
</tbody>
</table>

**Sample learner work**

**Task 1**

**Worksheet 1: Atomic structure**

Study this diagram and then answer the questions that follow.

1. Name the dense central region of the atom labelled A.
   *Nucleus*

2. Name particle B, which has no charge and a relative mass of 1.
   *Neutron*

3. Name particle C, which has a positive charge and a relative mass of 1.
   *Proton*

4. Name the negatively charged particle D that orbits the central dense region of the atom.
   *Electron*

5. What is the atomic number of this atom?
   *5*

6. What is the mass number of this atom?
   *11*

7. Identify the element.
   *Boron*
Worksheet 2: The electronic structure, atomic number and mass number of the first twenty elements

Complete this table, which relates to the electronic structure, atomic numbers and mass numbers of the first twenty elements.

<table>
<thead>
<tr>
<th>Element</th>
<th>Symbol</th>
<th>Atomic number</th>
<th>Mass number</th>
<th>Number of protons</th>
<th>Number of neutrons</th>
<th>Number of electrons</th>
<th>Electronic structure (shells)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen</td>
<td>H</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1s 2s 2p 3s 3p 4s</td>
</tr>
<tr>
<td>Helium</td>
<td>He</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1s 2s 2p 3s 3p 4s</td>
</tr>
<tr>
<td>Lithium</td>
<td>Li</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1s 2s 2p 3s 3p 4s</td>
</tr>
<tr>
<td>Beryllium</td>
<td>Be</td>
<td>4</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>1s 2s 2p 3s 3p 4s</td>
</tr>
<tr>
<td>Boron</td>
<td>B</td>
<td>5</td>
<td>10</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>1s 2s 2p 3s 3p 4s</td>
</tr>
<tr>
<td>Carbon</td>
<td>C</td>
<td>6</td>
<td>12</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>1s 2s 2p 3s 3p 4s</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>N</td>
<td>7</td>
<td>14</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>1s 2s 2p 3s 3p 4s</td>
</tr>
<tr>
<td>Oxygen</td>
<td>O</td>
<td>8</td>
<td>16</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>1s 2s 2p 3s 3p 4s</td>
</tr>
<tr>
<td>Fluorine</td>
<td>F</td>
<td>9</td>
<td>18</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>1s 2s 2p 3s 3p 4s</td>
</tr>
<tr>
<td>Neon</td>
<td>Ne</td>
<td>10</td>
<td>20</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>1s 2s 2p 3s 3p 4s</td>
</tr>
<tr>
<td>Sodium</td>
<td>Na</td>
<td>11</td>
<td>22</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>1s 2s 2p 3s 3p 4s</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Mg</td>
<td>12</td>
<td>24</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>1s 2s 2p 3s 3p 4s</td>
</tr>
<tr>
<td>Aluminium</td>
<td>Al</td>
<td>13</td>
<td>26</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>1s 2s 2p 3s 3p 4s</td>
</tr>
<tr>
<td>Silicon</td>
<td>Si</td>
<td>14</td>
<td>28</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>1s 2s 2p 3s 3p 4s</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>P</td>
<td>15</td>
<td>30</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>1s 2s 2p 3s 3p 4s</td>
</tr>
<tr>
<td>Sulphur</td>
<td>S</td>
<td>16</td>
<td>32</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>1s 2s 2p 3s 3p 4s</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Cl</td>
<td>17</td>
<td>34</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>1s 2s 2p 3s 3p 4s</td>
</tr>
<tr>
<td>Argon</td>
<td>Ar</td>
<td>18</td>
<td>36</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>1s 2s 2p 3s 3p 4s</td>
</tr>
<tr>
<td>Potassium</td>
<td>K</td>
<td>19</td>
<td>38</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>1s 2s 2p 3s 3p 4s</td>
</tr>
<tr>
<td>Calcium</td>
<td>Ca</td>
<td>20</td>
<td>40</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>1s 2s 2p 3s 3p 4s</td>
</tr>
</tbody>
</table>

Worksheet 3: The electronic structures of the first twenty elements

Complete the electronic structures of the first twenty elements, using crosses to represent electrons.

- Hydrogen
- Helium
- Lithium
- Beryllium
- Boron
- Carbon
- Nitrogen
- Oxygen
- Fluorine
- Neon
- Sodium
- Magnesium
- Aluminium
- Silicon
- Phosphorus
- Sulphur
- Chlorine
- Argon
- Potassium
- Calcium
Worksheet 4: The periodic table

Answer these questions on the periodic table.

1 What names are given to the vertical columns and horizontal rows in the periodic table?
   Vertical columns: Groups  
   Horizontal rows: Period

2 Complete this table.

<table>
<thead>
<tr>
<th>Element</th>
<th>Atomic number</th>
<th>Period</th>
<th>Group</th>
<th>Metal or non-metal?</th>
<th>Block (s, p or d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boron</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>Non Metal</td>
<td>p</td>
</tr>
<tr>
<td>Oxygen</td>
<td>8</td>
<td>2</td>
<td>6</td>
<td>Non Metal</td>
<td>s</td>
</tr>
<tr>
<td>Sodium</td>
<td>11</td>
<td>3</td>
<td>1</td>
<td>Metal</td>
<td>s</td>
</tr>
<tr>
<td>Aluminium</td>
<td>13</td>
<td>3</td>
<td>3</td>
<td>Metal</td>
<td>p</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>15</td>
<td>3</td>
<td>5</td>
<td>Non Metal</td>
<td>p</td>
</tr>
<tr>
<td>Iron</td>
<td>26</td>
<td>4</td>
<td></td>
<td>Metal</td>
<td>d</td>
</tr>
</tbody>
</table>

3 a) State what happens to the melting points of the elements as a period is crossed.

The melting point rises to around 4000° Kelvin but when it reaches Group 4 the melting point drops to 0° in Group 5 and stays this way across the rest of the period.

b) State what happens to the first ionisation energy of the elements as:
   i) a period is crossed: it increases
   ii) a group is descended: it decreases

c) State what happens to the atomic radii of the elements as:
   i) a period is crossed: it decreases
   ii) a group is descended: it increases

4 Consider these three elements: magnesium (Mg), silicon (Si) and chlorine (Cl).
   a) Place them in order of their melting points:
      Highest: Si  Middle: Mg  Lowest: Cl
   b) Place them in order of their first ionisation energies:
      Highest: Cl  Middle: Si  Lowest: Mg
   c) Place them in order of their atomic radii:
      Largest: Mg  Middle: Si  Smallest: Cl

5 Consider these three elements: lithium (Li), sodium (Na) and potassium (K).
   a) Place them in order of their first ionisation energies:
      Highest: Li  Middle: Na  Lowest: K
   b) Place them in order of their atomic radii:
      Largest: K  Middle: Na  Smallest: Li

6 a) Predict which two of the elements listed below are most likely to show chemical reactions similar to those of chlorine.
   argon  bromine  calcium
   iodine  magnesium  phosphorus
   potassium  rubidium  silicon
   strontium  sulphur

   Elements showing similar chemical reactions to chlorine: bromine, iodine

b) Which element of the two that you have given as your answer to 6 a) is likely to be the most reactive with water?
   bromine

c) From the list of elements given in question 6 a), select two elements that:
   i) produce basic oxides upon reaction with oxygen:
      magnesium  calcium
   ii) produce acidic solutions upon reaction with water (argon, phosphorus and sulphur don’t react with water):
      silicon  iodine
Worksheet 5: Bonding

1. Complete these sentences by filling in the missing words.
   - Ionic compounds are formed by the transfer of electrons between atoms.
   - Metals form positively charged ions by losing electrons whereas non-metals form negatively charged ions by gaining electrons.
   - Oppositely charged ions attract each other electrostatically. The ions form giant regular lattice structures in which several oppositely charged ions attract each other.
   - Covalent compounds are usually formed between non-metals.
   - They are formed by the sharing of a pair of electrons.
   - Each atom in a covalent bond contributes (a number) one electron(s) to the bond.
   - In both types of bonding the atoms of the elements become more stable by achieving the same electronic configuration as a noble gas.

2. Complete the table by listing the type of bonding in each substance.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Type of bonding</th>
</tr>
</thead>
<tbody>
<tr>
<td>NaF</td>
<td>Ionic</td>
</tr>
<tr>
<td>MgO</td>
<td>Ionic</td>
</tr>
<tr>
<td>CCl₄</td>
<td>Covalent</td>
</tr>
<tr>
<td>SO₂</td>
<td>Covalent</td>
</tr>
<tr>
<td>CaS</td>
<td>Ionic</td>
</tr>
<tr>
<td>Cl₂</td>
<td>Chlorine</td>
</tr>
</tbody>
</table>

3. a) Identify the type of bonding in KF.
   - Ionic

   b) Complete this dot and cross diagram for KF, showing only the outer electron shells.

4. a) Identify the bonding in CH₄.
   - Covalent

   b) Complete this dot and cross diagram for methane, showing only the outer electron shells.

   c) What name is given to the arrangement of the H atoms around the central carbon atom in CH₄?
   - Tetrahedral arrangement

   d) Draw a three-dimensional representation of a molecule of CH₄. Show the angle between the C-H bonds on your diagram.
**Task 2**

**Worksheet 6: Preparation of a standard solution of sodium carbonate**

**Procedure**

Weigh an empty weighing boat and record its mass in the table (see readings below).

Add about 1.5 g sodium carbonate to the boat and record the mass accurately.

Transfer the sodium carbonate to a beaker and reweigh the boat recording its mass in the table.

Add about 100 cm³ of distilled water to the beaker containing the sodium carbonate and stir to dissolve.

Transfer the solution to the 250 cm³ volumetric flask using a funnel, washing down the stirring rod with a small amount of distilled water from a wash bottle. Rinse the beaker into the funnel again using distilled water from the wash bottle, and finally rinse the funnel and remove it before making up to the mark on the volumetric flask with distilled water. Add the last few drops of distilled water with a pastette (transfer pipette).

**Readings**

<table>
<thead>
<tr>
<th>Reading</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass of weighing boat in grams</td>
<td>2.210 g</td>
</tr>
<tr>
<td>Mass of weighing boat + Na₂CO₃ in grams</td>
<td>3.706 g</td>
</tr>
<tr>
<td>Mass of weighing boat + residual Na₂CO₃ in grams</td>
<td>2.221 g</td>
</tr>
</tbody>
</table>

**Calculations**

\[
\text{Mass of Na₂CO₃ in grams} = 3.706 - 2.221 = 1.485 \text{ g}
\]

\[
M_r \text{ of Na₂CO₃} = (23 \times 2) + 12 + (16 \times 3) = 46 + 12 + 48 = 106
\]

\[
\text{Moles of Na₂CO₃} = \frac{1.485}{106} = 0.014
\]

\[
\text{Volume} = \frac{250}{1000} = 0.25
\]

\[
\text{Concentration of Na₂CO₃ in mol dm}^{-3} = 0.014 / 0.25 = 0.0560 \text{ mol dm}^{-3}
\]

**Worksheet 7: Titration to determine the equation for the reaction between hydrochloric acid and sodium carbonate**

The equation for the reaction between hydrochloric acid and sodium carbonate is to be determined by titration.

**Reagents and apparatus**

- HCl 0.12 mol dm⁻³
- Na₂CO₃
- Burette (50.0 cm³), clamp and stand
- Conical flasks
- Water wash bottle
- White tile
- Methyl orange indicator
- Bulb pipette (25.0 cm³) and filler
- Funnel

**Safety**

There are no major hazards in this experiment. Hydrochloric acid is corrosive and can cause burns. Sodium carbonate is an irritant. Safety glasses and gloves should be worn to protect the eyes and hands, and a laboratory coat should be worn to protect clothing.

**Procedure**

Clamp the burette into a burette stand, ensuring that the tap is closed. Use a small funnel to fill the burette with hydrochloric acid until past the zero point. This will make sure that when finding zero, the tip of the burette is full of liquid and has no air bubbles. Remove the funnel and level to zero, observing the meniscus at 90°.

Pipette 25.0 cm³ of the solution of sodium carbonate into a conical flask and add two to three drops of methyl orange indicator. Record the initial volume of hydrochloric acid in the burette to two decimal places. Carry out a rough titration. Record the final volume of hydrochloric acid in the burette.

Repeat the titration until you obtain two titres within 0.20 cm³. Note, it is unlikely you will have the time to carry out more than four titrations in total.

**Results**

The indicator colour changed from yellow to pink.

<table>
<thead>
<tr>
<th>Titration results for sodium carbonate against hydrochloric acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rough 1 2 3</td>
</tr>
<tr>
<td>Final burette reading/cm³</td>
</tr>
<tr>
<td>Initial burette reading/cm³</td>
</tr>
<tr>
<td>Volume of hydrochloric acid used/cm³</td>
</tr>
</tbody>
</table>

Average titre / cm³: 22.43
The average titre was calculated using titres 2 and 3.
Worksheet 7: continued...

Calculations

1. Calculate the moles of sodium carbonate used in the titration.
   (You know the concentration of the standard solution of sodium carbonate from the practical you undertook in Worksheet 6, and you have used 25.0 cm³ in this titration.)
   \[
   \text{Moles} = \text{conc.} \times \text{vol (dm}^3) = \frac{25.0 \text{ cm}^3}{1000} = 0.025 \text{ dm}^3
   \]
   \[
   \text{Moles} = 0.056 \times 0.025 = 1.4 \times 10^{-3}
   \]

2. Calculate the moles of hydrochloric acid used in the titration.
   (You know the volume of HCl required for neutralisation and the concentration of the solution of HCl.)
   \[
   \text{Moles} = \text{conc.} \times \text{vol (dm}^3) = \frac{22.63 \text{ cm}^3}{1000} = 0.02263 \text{ dm}^3
   \]
   \[
   \text{Moles} = 0.02263 \times 0.12 = 2.7136 \times 10^{-3}
   \]

3. Calculate the ratio of the number of moles of HCl and Na₂CO₃ reacting.
   \[
   \frac{2 \text{ mole(s) of HCl react(s) with 1 mole(s) of Na₂CO₃}}{2.7136 \times 10^{-3} \div 1.4 \times 10^{-3} = 1.94}
   \]

4. Write a balanced equation for the reaction between HCl and Na₂CO₃, remembering that a carbonate reacts with an acid to form a salt, carbon dioxide and water.
   \[
   \text{Na₂CO₃} + 2 \text{ HCl} \rightarrow 2\text{NaCl} + \text{CO}_2 + \text{H}_2\text{O}
   \]

Analysis

1. Do you think your results are reproducible? Give your reasoning.
   The results should be reproducible using the same solutions.

2. Do you think that your results are accurate? Give your reasoning.
   The results were fairly accurate having done them several times. This reduces the risk of very inaccurate results.

3. What do you think are the major sources of error in this experiment?
   Not reading the burette accurately.
   Not seeing the colour change at exactly the right time.
Task 3

Chemical equations are used in the titration on Worksheet 7 to allow the calculation of the molecular formula of the carbonate. The chemical equation used gives the exact number of moles of the reactants and the products. From this, you can calculate the number of moles of the unknown cation in the carbonate since the molar value of the hydrochloric acid has been calculated (that is, the unknown carbonate value is double).

Since you need to calculate the number of moles present in 250 cm$^3$ (the previous answer is for a volume of 25 cm$^3$), you need to multiply the answer by 10. From this, you can calculate the molecular weight of the unknown cation in the carbonate since you know the number of moles and the weight of the carbonate reacting (using the formula $\text{Mr} = \text{mass}/\text{number of moles}$). With the molecular weight of the carbonate known, you can now deduce what the unknown cation is. Subtracting the Mr of the CO$_3$ group and dividing the answer by 2 (since in the equation there are two atoms of X bonding with the CO$_3$ group) should give an approximate Mr of 39. This is potassium.

Ionic bonding is present in the potassium carbonate compound, since it is comprised of a metal and non-metal group. They bond in the ratio K=2 and CO$_3$=1 since potassium is in group 1 of the periodic table, having a valency of +1 (that is, needs to lose one electron to have a full outer shell). The CO$_3$ group has a valency of –2, therefore two potassium atoms will give a total of two electrons to the CO$_3$ group. With the HCl, hydrogen needs one electron to fill its outer shell and chlorine is in group 7 of the periodic table, so it needs one electron to fill its outer shell. Since the two elements are non-metals they will bond covalently, sharing electrons to fill their outer shells as seen in the earlier tasks of this assignment.

The products of the titration are KCl + CO$_2$ + H$_2$O. The metallic potassium in group 1 will react with the chlorine from group 7 to form an ionic compound. With the potassium being in group 1, it will give an electron away to the chlorine (group 7) resulting in both atoms having full outer shells. The carbon dioxide involves non-metallic bonding (covalent bonding) and with the oxygen being in group 6 (needing two electrons to fill its outer shell) and the carbon being in group 4 (needing four electrons to fill its outer shell) a double bond will form, resulting in full outer electron shells for both elements. The hydrogen dioxide involves non-metallic bonding (covalent bonding) and with the oxygen being in group 6 (needing two electrons to fill its outer shell) and the hydrogen needing one electron to fill its outer shell, covalent bonds will form resulting in full outer electron shells for both elements.

### The periodic table

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The periodic table

- Alkali metals
- Halogens
- Transition metals
- Noble gases

---

Task 4

**How are standard solutions prepared?**

A standard solution is a solution whose concentration is known accurately. Its concentration is usually given in mol dm$^{-3}$. To find the concentrations of other substances in solution, a standard solution is used.

When making up the standard solution it is important that the correct mass of substance is accurately measured. It is also important that all of this is successfully transferred to the volumetric flask used to make up the solution accurately.

The acid titre can itself be used as a standard solution once its concentration has been determined by titrating against a known concentration of alkali solution.

Analysis of a chemical species can be achieved using **standard solutions**. Varying concentrations differ in their absorbance of light at particular wavelengths, and so a sample solution compared to various known standard solutions and their absorbances at certain wavelengths (using Beer’s law) can be used to determine its concentration.

Standard solutions used in industry may have been prepared by another company and delivered to the testing point, or it may be part of the technician’s job to prepare these solutions. These solutions themselves will undergo rigorous testing by the manufacturer or the technician to prove their accuracy before they can be used in the quality assurance of the products.

Using standard solutions, titrations of many types can be carried out.

**The volumetric analysis**

To determine the chemical differences of solutions in reactions, volumetric analysis is carried out. This type of analysis can also be used in oxidation/reduction (redox) reactions.

**Titrination**

This is a technique used to find the volumes of solutions which react together. It is therefore called volumetric titration.

There are three types of volumetric titration:

- **DTM** – Direct Titration Method (single step process)
- **ITM** – Indirect Titration Method (two step process)
- **BTM** – Back Titration Method (three step process)

**Principle**

During a titration, a base and an acid will achieve equilibrium and the equation will be balanced. This is the principle of the method. Equilibrium occurs once the end-point is reached.

**The process**

A solution of analyte is prepared and added to a conical flask with a suitable indicator. The sample to be determined (titrand) is added drop by drop to the analyte until there is a change in colour.
Appendix: A sample assignment

There are many different reasons why a titration might be carried out in industry. In the waste oil industry oil titration is an indicator test for free fatty acids (FFA) in restaurant fryer oil, which only takes 30 seconds to titrate. It is done by reacting a small sample of the FFA with a measured amount of lye using pH to indicate when the FFA is all used up.

FFA is an acid produced by the heating and cooking of food with oil over time. As FFA accumulates it causes used vegetable oil to become more and more acidic. Oil which has been overheated or over-used can turn into a product that has been implicated in cancer.

Variations on these titrations are used in the petrochemical industry to define the differences in acidity of waste oil that is to become biodiesel. This process is becoming increasingly popular as the price of oil and petrol is rising rapidly.

Titrations are carried out in many industries including the water industry, in which they are used to check the quality of our drinking water; the dairy industry, for testing milk and cheese products; and the pharmaceutical industry, for checking the quality of drugs on the production line, to name just a few of their industrial applications. Titration in industry for different types of investigation need to be extremely precise and consistent compared to the class titration. The major difference between titrations in industry is that they may use machinery that is capable of delivering the exact amount of reactant needed and other equipment to perform the process. These processes may take place without the need for intervention of laboratory staff. It also means that the machine is able to read the results for the end point down to minute fractions and therefore, be incredibly precise.

In industry the theory behind the simple volumetric titration is exactly the same as has been investigated in this practical work. Although the industrial production scale may be very large the laboratory testing and quality assurance may be on a small scale and may still be done manually although it will be going on at all times and covering different points in the manufacturing process. Some examples of the processes associated with titration in industry will include the simple manual addition of titrant to analyte with the addition of an indicator where the end point is determined by eye. Sugar and salt determinations are commonly performed in food laboratories using manual colourmetric end point titrations but can suffer from the production of colour during the reactions so masking the indicator making the end point difficult to see. However some processes must be monitored continuously to monitor the progress of the process.

Where titrations are required on a continuous basis, instrument manufacturers can provide a complete system, which includes an ion selective electrode, reference electrode, electrode head, pH electrode, temperature sensor, electrode-computer interface, and ion analyser software.
Applications include:
- water quality analysis of surface and ground waters, fish ponds, aquaculture, sewage, and industrial effluent
- food and drink quality control, bio-reactors and fermentors
- monitoring of the progress of the process of alcohol production for both industrial use and consumption;
- pharmaceutical, agricultural and medical research.

In the pharmaceutical and cosmetic industries, surfactants (anionic, cationic and non-ionic) are used to allow substances to flow or spread more easily by reducing the surface tension of water within it. The quality and content of the surfactant can be determined by suitable applied methods of titration.

For each type of industry manufacturers will produce automated equipment to meet the specific needs of the processes being carried out. All of these processes may not be using titration but will be monitoring production and processing.

Coulometry
This process uses the principles of electrical charge within chemical solutions to determine their concentrations. In this way, a very accurate determination of standard concentrations can be obtained. The oxidation or reduction state of the analyte is changed by using a constant electrical current of specified charge.

A change in potential happens and this indicates the end-point. Knowing the current used and the time taken, calculations can determine the concentration of the analyte.

(1 Faraday = 96,485 coulombs = 1 mole of electrons)
Teaching BTEC: BTEC Level 3 Nationals in Applied Science

Analyte.

which will affect the analyte concentration is the relative size of the electrode compared to the volume of the analyte.

The concentration of the analyte will, therefore, depend on the rate of diffusion of the analyte. Another factor which will affect the analyte concentration is the relative size of the electrode compared to the volume of the analyte.

Amperometric titration

Where coulometric titration applies an electrical current for a given time, amperometric titration involves the measurement of the electrical current produced at end-point of the reaction. It is, therefore, a form of quantitative analysis.

Example – an electrolytic potential is applied to an analyte solution and conductive buffer. The measured electrical current can be used to determine the concentration of the analyte since the concentration affects conductivity. This is a form of amperometry.

However, the amount of electrical current is also dependent on other factors which are not all easily controllable. This may account for a lack of precision in this method of analysis.

The analyte concentration is subject to variations which are directly linked to the applied electrical potential. This is more noticeable at close proximity to the electrode where analyte reduction can take place more readily than at areas away from the electrode.

The concentration of the analyte will, therefore, depend on the rate of diffusion of the analyte. Another factor which will affect the analyte concentration is the relative size of the electrode compared to the volume of the analyte.

Amperometric titration

This is a titration in which the titrant and solution cause the formation of a metal complex accompanied by an observable change in light absorbance by the titrated solution.

When light is used as the principal form of analysis, it is essential to select an appropriate wavelength for analysis, since all components in a titration (titrant, analyte and products) absorb light. Every effort is made to select a wavelength absorbed by only one component. The part of the molecule responsible for producing this light (chromophore) must follow Beer’s law at this particular wavelength. This means that there is a change in the observed absorbance characteristic as the concentration of the absorbing species changes. A graph of absorbance against titrant volume should produce a straight line.

The absorbance concentration changes up to the point of equivalence but does not change any further even when more titrant is added.

Two straight lines produced on the graph, absorbance/titrant volume up to the end point and absorbance/titrant volume beyond the end point, will intersect at the equivalence point.

The accuracy of this method is brought into question when absorbance levels are very high. Consequently, percentage transmittance (%T) of the selected wavelength is low, and so it is desirable to choose lower analyte concentrations, a buffer and wavelengths associated with low absorbance changes.

Industrial application of amperometric titration

This type of titration is used to analyse the contaminants such as zinc and zinc salts in the manufacture of theophylline for pharmaceutical use. Such contaminants prevent the use of other equipment in the manufacturing process.

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Sample learner work: page 19

**Industrial application of conductivity titration**

For use in situations where a strong acid and strong base are in use and where an indicator colour may be masked by the titrant, analyte or its products.

Visual or photometric indication titration relies on the colour change in the range of the indicator. Temperature can considerably affect the end point of a titration so solutions must be kept at a constant temperature if consistent results are to be obtained. This will require monitoring and control if automatic testing is being undertaken.

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### Sample assessor’s comments

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**Learner feedback**

I worked hard on this assignment but I did find it difficult to obtain information on the industrial uses of titrations.

**Assessor feedback**

You have successfully provided evidence using the worksheets provided for P1 in Task 1 and 2, identifying and describing the atomic structure, information from the periodic table, bonding and titration. You have carried out the practical work in a safe and accurate manner for P2. In Task 3 you produced some valid conclusions from the practical work. Finally you have written succinctly about the preparation of standard solutions and how titrations are carried out in industry. D1 has therefore been achieved. An excellent assignment.

**Action plan**

Continue to read generally around the subject and build on your very good work.

---

**Assessor signature**

J Morris  
**Date**  
19 January 2011

**Learner signature**

Jason Evans  
**Date**  
19 January 2011
## Sample internal verification of assessment decisions

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