BTEC FIRST

edexcel

BTEC

Award

Delivery Guide

PRINCIPLES OF APPLIED SCIENCE

From September 2012

Edexcel BTEC Level 1/Level 2 First Award in Principles of Applied Science

ALWAYS LEARNING

PEARSON

Pearson Education Limited is one of the UK's largest awarding organisations, offering academic and vocational qualifications and testing to schools, colleges, employers and other places of learning, both in the UK and internationally. Qualifications offered include GCSE, AS and A Level, NVQ and our BTEC suite of vocational qualifications, ranging from Entry Level to BTEC Higher National Diplomas. Pearson Education Limited administers BTEC qualifications.

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Welcome to your BTEC First 2012 delivery guide

This guide is a companion to your BTEC First Award specification. It contains a wealth of ideas for practical activities, realistic scenarios and independent learning, helping to bring the content of the units to life. The aim of this guide is to show how the content of the specification might work in practice and to inspire you to start thinking about different ways to deliver your course. The guidance has been put together by teachers who understand the challenges of finding new and engaging ways to deliver a BTEC programme, which means you can be sure the guidance is relevant and achievable.

Unit-by-unit guidance is given and includes suggestions on how to approach the learning aims and unit content as well as providing ideas for interesting and varied activities. You will also find a list of carefully selected resources for each unit, including suggestions for books, websites and videos that you can either direct your learners to use or that you can use as a way to complement your delivery.

Guidance about the new features of the BTEC Firsts is also included, providing an explanation of how these work and what you will need to consider as you plan the course. You will also find comprehensive coverage of assessment, including useful advice about external assessment, as well as extensive guidance about how to plan, design and deliver your assignments. Information about the Quality Assurance process will help you understand the different roles and responsibilities of individuals within your centre, and how you can work closely with Pearson to enable the successful running of your programme.

This delivery guide is intended to be read in conjunction with the qualification specification.

- The specification tells you what must be taught and gives guidance about how it should be assessed.
- This delivery guide gives suggestions about how the content could be delivered.

The suggestions given in this delivery guide link with the suggested assignment outlines in the specification but they are not compulsory; they are designed to get you started and to spark your imagination.

Remember that all assignments must go through internal verification before being delivered to learners.

When combining units for a BTEC First qualification, it is the centre's responsibility to ensure that the qualification structure(s) in the specification are adhered to.

Contents

1 Introducing the new BTEC First Award in Principles of Science

BTEC First qualifications were originally designed for use in colleges, schools and the workplace as an introductory level 2 course for learners wanting to study in the context of a vocational sector. This is still relevant today. The skills learnt in studying a BTEC First will aid progression to further study and prepare learners to enter the workplace in due course.

BTECs are vocationally related qualifications, where learners develop knowledge and understanding by applying their learning and skills in a work-related context. Additionally, they are popular and effective because they engage learners to take responsibility for their own learning and to develop skills that are essential for the modern-day workplace.

These skills include: team working; working from a prescribed brief; working to deadlines; presenting information effectively; and accurately completing administrative tasks and processes. BTEC Firsts motivate learners and open doors to progression into further study and responsibility within the workplace.

The BTEC Level 1/Level 2 First Award in Principles of Applied Science has been designed to deliver the Key Stage 4 Programme of Study for science by covering the key scientific principles vital for both scientists and citizens of the future. The qualification is appropriate for learners of all abilities who will benefit from a practical and applied approach to learning in a vocational context. It has been developed to:

- exemplify scientific principles in vocational contexts, leading to an understanding of how those principles are applied in practice and how they can facilitate a move either onto further periods of study or into employment
- give learners the opportunity to gain a broad understanding and knowledge of science principles and practice.

The BTEC philosophy of learning through doing remains at the heart of this qualification. Learners will be given the opportunity to gain a broad understanding and knowledge of, and skills in, the applied science sector.

Developing the qualification in response to change

The new suite of BTEC Firsts are now available on the National Qualifications Framework (NQF). The NQF fully supports both academic and vocationally related progression pathways and is not purely for competency-based qualifications like the QCF.

Professor Alison Wolf's *Review of Vocational Education* was published in March 2011. The Government has since accepted her proposals in full. Consequently, the Department of Education (DfE) has produced a list of seven characteristics that all high quality vocational qualifications for pre-16 learners should demonstrate. Specifically, qualifications should:

1. Be at least as big as a GCSE in terms of Guided Learning Hours (GLH) – 120 GLH.
2. Contain a minimum of 20% external assessment e.g. an externally set and marked test taken under specific conditions.
3. Contain some synoptic assessment so that learners appreciate the breadth of their course and the links between different elements – not just take a discrete number of units in isolation from each other.
4. Be graded – e.g. Pass, Merit, Distinction and Distinction*.

5. Contain content appropriate for 14-16 year olds.
6. Enable progression to further study in the same subject at the next level, and also support progression more widely to broader study at the next level.
7. Have a proven track record, measured by its uptake of at least 100 learners in five centres.

As part of the development of the new BTEC Firsts in Principles of Applied Science we have taken into account:

- policy reports into the applied science sector
- many consultations with schools, FE, HE and employers.

Principles of Applied Science adopts a different structure from other qualifications in the suite, to reflect the unique nature of science learning. To ensure sufficient breadth and depth, Applied Science has two Awards instead of a single Award. This Delivery Guide is for the Pearson BTEC Level 1/Level 2 First Award in Principles of Applied Science. There is an additional Delivery Guide for the Pearson BTEC Level 1/Level 2 First Award in Applications of Science.

Progression opportunities

This qualification builds on the foundation of the Key Stage 3 science Programme of Study. Learners should progress from this qualification to the Pearson BTEC Level 1/Level 2 First Award in Application of Science.

Learners can then progress to the BTEC Level 3 Nationals in Applied Science, including the Forensic Science and Medical Science endorsed pathways or complete extended certificates or diplomas within the BTEC Level 1/Level 2 First suite.

Learners can also progress to a range of BTEC Level 2 National qualifications in related areas such as Beauty Therapy Science, Health and Social Care, Sport and Exercise Science, Engineering, Construction, Land-based, Pharmacy Services or Dental Technology. Alternatively, they can progress to NVQs such as the Laboratory and Associated Technical Activities or Laboratory Science.

The underpinning knowledge, practical and vocational scientific skills learnt on the Principle of Applied Science course will enhance and support the progression to a competency-based course.

For learners who wish to progress to GCEs in science it is recommended that they also take further units from the larger-sized BTEC First qualifications and are provided with support on GCE assessment methods.

Comparing specification structures and unit content

A table mapping the content of the new BTEC First Award against the BTEC Level 2 First Extended Certificate (QCF) will be made available. This mapping will help you transition from one specification to the other by highlighting where there are changes in content; particularly where there is new content which will need to be delivered to help your learners prepare for the new assessment. To access this table visit www.btec.co.uk/2012.

2 Key features of the BTEC First Awards explained

We are always working to ensure that our qualifications are relevant, and that they support opportunities and progression for young people. We have updated the current BTECs to meet the needs of today's learners, teachers, educators, employers and universities, and also to reflect the policy decisions being introduced following *The Wolf Report* (March 2011) on vocational education. Our new BTECs contain a number of new features and it is important that you understand these and how they relate to your delivery of the course.

Mandatory units

The BTEC Level 1/Level 2 First Award in the Principles of Applied Science contains four mandatory units totalling 120 guided learning hours (GLH). These units have been developed in consultation with employers and educators who deliver vocational qualifications at levels 2 and 3. They cover the essential knowledge and applied skills that are a foundation of the sector, and the knowledge and skills that will underpin learning and that are considered essential for 14–19 year-old learners. The four units in the Award are:

- *Unit 1: Principles of Science*
- *Unit 2: Chemistry and Our Earth*
- *Unit 3: Energy and Our Universe*
- *Unit 4: Biology and Our Environment*

Unit 1 is externally assessed through a one hour examination. The external assessment provides independent confirmation that the standards are being met but, as it represents a maximum of 25 per cent of the overall assessment, does not distort the general BTEC approach, which continues to focus on predominantly portfolio-based applied learning.

Contextualised English and mathematics

The BTEC Firsts qualifications 2012 have been designed to help learners to develop their essential skills in English and mathematics.

It is recognised that good literacy and numeracy skills are highly valued by employers and by wider society and that achievement of English and mathematics at GCSE level is key to progression through the education system and into employment. The current Government has refocused attention on this need with a number of education policy announcements, and development of English and mathematics was a key recommendation in *The Wolf Report*.

Research has shown that for many learners the most effective way of developing their mathematical skills and of improving their functional skills in English is to learn them within the context of a specific area of vocational interest. Therefore, in the new suite of BTEC Firsts we have provided opportunities for contextualised maths and English so that learners can practise these essential skills in a meaningful way within naturally occurring contexts.

GCSEs in mathematics and English are the current benchmark of achievement, so we have signposted the BTEC Firsts assessment criteria to content from these GCSE qualifications, specifically to the more functional parts of their content. This signposting, which is indicated by a * sign for maths and a # sign for English, shows where learners should be able to practise and develop their skills. These instances

occur naturally within the BTEC Firsts, for example when communicating or compiling reports, but can be emphasised and drawn out during teaching and learning. More detail on how this can be done is given on a unit-by-unit basis in the qualification specification.

Where signposting does occur in the unit specification, it indicates that English and mathematics knowledge and skills are a constituent part of the assessment requirements of the units. This does not mean that the BTEC assessment criteria cover the whole of the GCSE or Key Stage 4 requirements but that learners can practice specific areas of English and mathematics. You may want to highlight this opportunity to learners during delivery.

Appendices B and C in the specification show the exact relationship between the BTEC assessment criteria and the GCSE subject content. The mathematics content listed is a consolidation of the full requirements in GCSE Mathematics. Note that GCSE English and GCSE Mathematics already cover functional skills.

The following example demonstrates when learners will be able to develop their mathematics skills within the context of a specific vocational area.

Unit 3: Energy and our Universe – 2B.P6, 2B.M4, 2B.D4 – where learners are using $V=IR$ to predict values in electric circuit investigations, they should be able to practise mathematical skills including understanding number, estimation, carrying out calculations and substituting numerical values into formulae and equations using the appropriate units (Mathematics 1–6, 13, 21, 24).

Delivery tips: examples of good practice

There are a number of different ways that your centre can effectively manage the delivery of units to strengthen the provision of English and mathematics. Here are two examples.

Collaboration between the vocational teacher and mathematics/English teachers

- In this example, the actual mathematics and English concepts are taught by subject teachers, but they use contextualised examples from the vocational sector to make the learning meaningful. The learners are in timetabled slots where they attend mathematics and English lessons.
- This approach works well in larger centres where there are many learners taking the same vocational route. It works less well when there are a range of vocational sectors in the same mathematics/English class, although it can still be effective if the respective teachers work closely together to plan the learning programme.

Mathematics and English are taught in specific lessons by the vocational tutor

- In this example, the learners have timetabled slots, as part of their vocational contact time, in which their vocational teachers focus on presenting and practising mathematics and English concepts. This model is particularly motivating for learners because they see the direct link between skills and application, but it relies on the vocational teachers being comfortable with teaching mathematics and English concepts and theories.

Whichever model is chosen, we recommend that timetables include specific slots to focus on the teaching of mathematics and English in the context of the vocational course.

Supporting learners who are unable to achieve their level 2 qualification

The new suite of BTEC Firsts is for learners aiming to achieve a level 2 qualification. Most will achieve this, but some will not. These learners may have struggled to provide sufficient evidence in their assignments or they may have failed their external assessment.

The new BTEC First qualifications give you the opportunity to assess your learners at level 1 if they are not able to reach level 2 standards, recognising their learning and achievements.

All the assessments you create must be written against the level 2 criteria and be reliable and fit for purpose. You should not create a separate level 1 assignment. If a learner does not provide sufficient evidence to meet the level 2 criteria, only then should you assess their work against the level 1 criteria. The grade given will be 'Unclassified' if the learner does not meet the level 1 criteria.

An example of a learner being assessed against a level 1 criterion

Below is an example of an assessment grid, taken from *Unit 2: Chemistry and Our Earth*. Each assessment grid includes level 1 assessment criteria.

Learning aim C: Investigate the factors involved in the rate of chemical reactions	
Level 1 criterion	Level 2 Pass criterion
1C.6 Identify the factors that can affect the rates of chemical reactions.	2C.P6 Describe the factors that can affect the rates of chemical reactions.

In the scenario below, learners are given the following assignment:

Assignment title: Controlling Industrial Reactions.

Scenario: As one of the production chemists working at the local chemical plant, you have been asked to explain to the chemical plant operatives the factors that affect rate, yield and atom economy of reactions.

Assessment evidence: You must provide evidence from experiments and collated data on chemical reactions in order to explain all the factors that make the reaction go faster, maximise yield and optimise atom economy. Produce your findings in a practical scientific report.

To achieve a level 2 pass learners must cover the effects of concentration, particle size, temperature and presence of a catalyst on the rates of chemical reactions, and show that, for example, increasing temperature increases the rate of reaction. In the scenario below, the learner has been given the same assignment as everyone else in the group; however, they are clearly not working at a level 2 standard.

As part of a wider investigation, Jo attempts three reactions and investigates using books and the internet factors that affect the rate of reactions. In doing so, she manages to give a list of the factors that can affect the rate of reaction. However she fails to properly describe the effects of these factors. Therefore while attempting to achieve 2C.P6 she has gathered sufficient evidence for 1C.6.

Learners who achieve at level 1 can consider the following progression routes.

- Use the skills, knowledge and experience they have gained to retake their level 2 qualification.
- Choose to study a different subject at level 2.
- Work towards an Apprenticeship at level 2.

3 Assessment guidance

Assessment for the new BTEC Firsts

BTEC assessment has always been about:

- ensuring that learners are assessed for their skills as well as their knowledge
- ensuring that learners are given the chance to show what they have learned in vocational and applied contexts
- allowing learners to be assessed when they are ready and when a centre is able to fully support them

While updating the BTEC Firsts, we have not changed these fundamentals – BTEC assessment will remain a positive statement of achievement.

The introduction of external assessment will reinforce learner engagement, giving them clear goals and targets in a way that helps them to understand the challenges of working life.

Experienced BTEC teachers should think about whether or not they need to change their delivery pattern to make sure they can provide access to external assessment at the best time. At the same time, there are some important developments in internal assessment that you should also be aware of as you plan your assessment for the year.

External assessment

After careful discussion with centres and other stakeholders, we have tailored the type of external assessment to meet the needs of the sector. All the external assessments will be distinctively vocational, enabling learners to apply their learning in vocational or applied contexts.

For your sector you need to check:

- which unit(s) are to be externally tested
- the assessment method
- the availability of assessment for the first time
- the availability of retake opportunities (allowing for results)
- the delivery pattern we are recommending for these units and for other units as given in the specification.

Remember that you have plenty of time to prepare for external assessments because you will be delivering over a one- or two-year period. For some sectors, completion of the externally assessed unit at, or very near, the end of the programme will be the recommended pattern. In others, it may be suggested that learners take the assessment earlier in the programme, but you should always make sure that learners are fully prepared.

The externally assessed unit will often be one that provides a core of knowledge that will be enhanced, developed and applied through other units. Learners' depth of understanding of the content of externally assessed units is likely to be enhanced by applying knowledge through other units. Therefore, when you are planning and delivering your units, think about how you can bring out examples that would be useful illustrations of issues covered in the external unit(s).

Each specification has details about when assessment is available. To gain access to the assessments, learners have to be registered for a programme – the

arrangements for this will be the same as for all BTECs. Please refer to the *Information Manual* on the website.

We will do everything we can to make external assessments relevant, engaging and suited to learners' needs so that they support the overall development of the learner rather than being a hurdle or distraction. You should not enter learners for external assessment to check how they are doing or to give them practice – we provide sample materials for use in preparation.

The table below shows the type of external assessment and assessment availability for this qualification.

This assessment forms part of the core knowledge of the programme and is likely to be delivered towards the start of the programme but may be complemented by study in the other core unit(s). A learner's overall readiness to undertake external assessment should be considered before entering for the assessment.

Unit 1: Principles of Science	
Type of external assessment	This unit is assessed externally using a paper-based exam marked by Pearson.
Length of assessment	The external assessment will be 60 minutes The assessment must be taken by the learner under examination conditions.
Number of marks	54
Assessment availability	November, March and June
First assessment availability	June 2013

Assessment and grading for internally assessed units

Internal assessment remains the main assessment method for BTEC qualifications because we believe that assignments set and marked within the centre provide the most relevant vocational learning experience for your learners.

You should guide both the teaching and the learning to then ensure that learners are assessed validly and reliably in a way that is relevant for a vocational qualification. Your teaching of the knowledge, skills and vocational applications will underpin a learner being able to demonstrate achievement through assessed assignments. Learners should be given formative feedback on their learning and skills development during the teaching and learning phase. You should consider carefully when your learners are ready to undertake an assessment. An assessed assignment must have a clear structure and timescale, and encourage the learner to work independently to show relevant evidence. You should make sure that the assessment is a clear, discrete activity. You can then make a qualitative judgement on the evidence using the assessment criteria.

Those who are used to teaching BTEC will find that not much has changed, but we are putting more emphasis on some requirements and helping to build good practice.

- You should make sure that the assessment is a clear, discrete activity. Evidence from the guided learning phase is not admissible because evidence for assessment must be produced independently.
- You should use the new presentation of units, where learning aims are placed with associated assessment criteria, to provide building blocks for assessment – these are clear and simple to use and we recommend that you work through them with your learners.

- Your assessment plan for each unit and for the programme must be clear at the outset of the programme and signed off by the Lead Internal Verifier.
- Your Lead Internal Verifier must authorise your assignments. If you don't have a Lead Internal Verifier who has been through standardisation you should use support from us to ensure that your assignments are fully fit for purpose. You can use the endorsed assignments or you can access the assignment checking service through our website.
- You need to be explicit about the timescales and the evidence for assignments – there is nothing new about this but we will be expecting centres to follow best practice and to be very clear with their learners.
- You need to set out expectations through tasks and evidence – remember that the criteria are used to judge evidence and are not tasks in their own right.
- **Summative** assessment takes place after the final submission date. You should also highlight what each of the dates on an assignment means. A learner may be given **one** opportunity to resubmit a completed assessment after a grade has been given where this has been correctly authorised.
- You should ensure that all work has been produced authentically and that you have checks in place to ensure that learners are submitting their own work.

How assignments are used

Assignments are used to assess learner achievement. You should usually work with the other people in your programme team to design a plan of activity for the year, or the programme as a whole, so that assignments have a clear schedule of start, finish and internal verification dates.

Ask yourself how many assignments you will need. Your assessed assignments should cover a minimum of one complete learning aim. You may choose to set an assignment for a whole unit, or even bring units together for assessment.

Remember that this means your **assessed** assignments. Of course, you may set activities before assessed assignments to provide opportunities for learning from formative feedback and through skills building. These preparatory activities may often use group work and research as a preparation for undertaking the assessment itself but cannot be contributory evidence towards an assessment.

In making a decision about how many assignments to use, you can think about what resources you have in your centre, what is available in the locality, how you could use links with local employers and what opportunities there are for relating assessment to realistic vocational themes.

Top tips

- If a unit builds up – for example by 'plan' and then 'do' and then 'review' – then one large assignment may work best.
- If a unit requires several forms of evidence then several assignments may be best.
- It is good to emphasise the links between units but it is harder to manage assessment across units – if you feel this is a good approach then be clear on how you will reach one decision for a unit.

You need to think about how the evidence that the learner will produce can be verified and about how you will know that what each learner has done is authentic. You can only accept for assessment learner work that you know has been produced in a way that demonstrates the learners' own achievement.

Assignment 'warm-up' – active teaching and learning

Your learners will do their best if they are motivated through engaging and realistic activities. All units involve 'teaching the basics' but learners need to get involved in order to understand where what they are learning fits in.

You can use your resources and your imagination to really bring learning alive. You can encourage learners to try things out in groups, role plays, presentations and practical demonstrations. You can use visits and talks for research – remember you will need to structure what you do so that learners get the information they need, such as by providing a question sheet for them to use during a talk or visit.

You can encourage learners to 'get their hands dirty' by trying something out. You can build up their skills so that they will be able to show them off confidently in the assessed assignment.

You can use this 'warm-up' time to emphasise practical links between units, so that when learners are carrying out tasks they appreciate that they are often simultaneously drawing on skills/understanding from different units. It is important that learners appreciate the holistic way that their learning prepares them for further study or employment.

Introducing the assignment

Your teaching and learning phase is going to lead directly into the assessed assignment. You may be setting this up in a very specific way – such as everyone completing a practical activity in a timed slot – or this may be independent work spread over a number of weeks.

It is important to remind learners preparing work for assessment that they have to produce it themselves and that they have to meet the deadlines you give them. Once learners begin work on an assignment no specific assessment feedback can be given.

Remember that you should be sure that your learners understand all the requirements for an assessed assignment before the assessment begins. Look at each unit carefully for how the evidence generated will be judged using the assessment criteria.

Evidence for assignments

You can use different types of evidence for assignments. A description does not have to be written and a presentation could be given in a number of styles – for example PowerPoint®, verbal or a video recording. You need to think about what is fit for purpose. So, if learners need to explain a plan, why not have them present it to an audience with a question and answer session?

You should check that the type of evidence you are planning is feasible – for example, if you ask learners to 'write a memo', the coverage of 1 or 2 sides of A4 must be capable of generating sufficient evidence. Likewise a poster may not be a suitable evidence format for a detailed evaluation.

Remember that whatever evidence your learners produce must be capable of being verified as well as assessed. So, if they are actually producing a model, a performance, a meal, a coaching session, a demonstration, etc. you need to think about how it will be observed or recorded so that it can be checked during verification.

Remember: no activity can be evidenced solely by an assessor's observation log or by a witness testimony. All observed evidence must be able to be authenticated to the learner. This means that observation logs must always be supported by learner-generated evidence such as preparation notes or reflective logs, or by photographic

or video evidence in which the learner can be identified. The totality of this evidence must be available to the assessor at the point of the assessment decision which must follow the handing in of an assignment. An assessor should not award criteria during an activity, e.g. at the point of completing an observation log.

Learning aims and assessment criteria

A learning aim sets out what you should be covering in order to prepare learners for assessment. It may define knowledge, understanding, skills and contexts and the wording of the aim will suggest appropriate learning experiences. You may set an assessed assignment on more than one learning aim, but you should not normally split a learning aim over assignments. If a learning aim has been split over more than one assignment then the assignments should be assessed summatively together. The evidence the learner produces in response to the assignment brief is judged using the assessment criteria, so you must make sure that what is produced will you have stated in the task fully covers those criteria.

What about the final grade for a unit?

The final grade for a unit is at Level 2 (Distinction, Merit or Pass), Level 1 or Unclassified. The assessment criteria are detailed in each unit so that you can clearly see what is required. You need to be aware that a unit grade can only be given once all the activities and assignments for that unit are complete. In giving assessment decisions to learners, you need to be clear about when you are giving a formal decision and how this relates to the assessment for the unit as a whole.

If you choose to include a learning aim in more than one assignment, you should be very clear with learners about how a judgement will be reached through looking at the evidence *across* the assignments. For example, the learner may be being asked to show the same skills in two different contexts. If so, they need to know if their performance in either is sufficient for assessment, or if they must perform to the same standard in both.

Keeping clear assessment records

You can only use assignments as assessment instruments effectively if you work closely with other members of the assessment team and keep accurate records of what you are doing. Your records help you and the team to plan, review, monitor and support learners and ensure that assessment is authentic and accurate.

The Lead Internal Verifier has a very important role in ensuring that each teacher, assessor and internal verifier on the programme understands the standards and the processes for keeping assessment documents.

Your records are there to help you get it right for your learners. The main documents that you use, which can be used electronically, are:

- an assessment and verification plan for the programme showing when each assignment starts and finishes, when it is verified and which unit(s) or learning aims it covers
- an assignment brief template ensuring that all the key requirements of an assignment are covered
- a record of internal verification for the assignment brief
- a record that the learner completes when submitting an assignment, which should include the date and a declaration of authenticity
- a record of internal verification for an individual sample of learner work

- a record of progress for each learner showing the assignments that have been completed and the assessment decisions given.

Giving grades

At the end of an assignment you will need to reach a decision on assessment. If an assignment covers a whole unit then this will be a final grade; if it covers part of a unit then it will be a component of a final grade. In either case it counts as an assessment decision and should be subject to internal verification and then finalised.

Your decisions must be checked according to the internal verification plan signed off by the Lead Internal Verifier. For each assignment, a sample of learner work must be reassessed fully by the Lead Internal Verifier, or another person acting as an Internal Verifier who has been directed by the Lead Internal Verifier. Once your decisions have been checked you can give these to the learners as 'final'.

Remember: you will then be able to accept only one further attempt from the learner to provide further or better evidence for the learning aim(s) covered in that assignment.

The assessment decision must be given to the learner on an appropriate assessment record document which contains the assessment decision, the assessor's declaration of authentication of the learner work, space for the Lead Internal Verifier to authorise a resubmission and specify the conditions where applicable, and the assessment feedback comments. Feedback to the learner for each learning aim must be constructive and criterion-based. The learner should understand why they have been awarded each criterion, and why they have not been awarded any others. It is also helpful to annotate the learner work to show exactly where evidence for each criterion can be found. The assessment feedback must **not** offer any further guidance to the learner. Further guidance means guidance that is beyond that available to them at the start of the assignment; they must not be told individually or specifically what they can do to be awarded further criteria. Care must be taken to maintain the independence of the learner to enable a resubmission opportunity to be authorised.

You can only award higher grades if a learner has demonstrated the requirements of lower grades. This does not mean that the criteria represent different tasks or stages – you should be able to apply the criteria to the same evidence if the assignment is structured carefully.

In order to achieve at level 2:

- **Distinction** – a learner must have satisfied all the Distinction criteria in a way that encompasses all the other level 2 criteria, providing evidence of outstanding depth, quality or application.
- **Merit** – a learner must have satisfied all the Merit criteria in a way that encompasses the level 2 pass criteria, providing evidence of enhanced depth or quality.
- **Pass** – a learner must have satisfied all the level 2 pass criteria, showing breadth of coverage of the required unit content and having the relevant knowledge, understanding and skills.

Achievement at level 1 can be recognised by satisfying all the level 1 criteria. A learner who has attempted the unit but not satisfied all the criteria defined for level 1 should be given U (unclassified).

Enabling higher achievement

Your assignments should provide opportunities for learners to achieve at the highest level and should promote stretch and challenge. Of course, not all learners will finally

achieve a Distinction or a Merit, but it is important that they are provided with the opportunity to do so.

You must look to structure assignments so that learners produce evidence that can be used across the grade levels –Learners should not have to 'get pass out of the way first'. To 'aim high' learners must be well prepared before they start the assignment and be encouraged to attempt to reach the highest standards All assessed activities must ask the learner to produce evidence that can be assessed against the full range of grades available.

Assignment design

Your assignments are a tool for encouraging learners to provide evidence for you to make assessment judgements. Good assignments are interesting and motivate learners well.

The components of an assignment are:

- **a scenario** – provides a setting and rationale for the assessment
- **evidence requirements** – set out exactly what the learner is expected to produce and how the assessment will take place
- **tasks** – set out what a learner needs to do to provide the evidence
- **scope** – outlines which unit(s) or learning aims are being covered and which criteria are being addressed
- **a timescale** – sets out start and hand-in dates.

Assignment briefs

Your assignments must be given to a learner formally as an assignment brief so that the learner knows they are being assessed and what is required of them.

The assignment brief includes:

- the qualification
- the title and number of the unit(s)
- an assignment title and number (if more than one per unit)
- the learning aims (if not a whole unit)
- the assessment criteria
- the evidence requirements
- the start date
- the hand-in deadline.

You should include a record that it has been given to the learner, normally by inserting the learner's name into a copy of the assignment brief, but this could be recorded electronically.

Your learners should be provided with a form or other record for declaring that their work is their own and for confirming the date of submission.

Using an endorsed assignment brief

We are preparing a bank of endorsed assignments briefs that you will be able to access at www.btec.co.uk/endorsedassignments. It will include at least one endorsed assignment brief for every internally assessed unit. For mandatory units, there will be enough endorsed assignment briefs to cover all assessment criteria.

We ask you to verify every assignment every year, regardless of whether it is your own or one sourced from elsewhere. Once your assignment is verified, you can put it in your timetable and check that you have planned delivery of the appropriate unit content. This can be as simple as making sure you have planned an event, visit or performance as suggested.

- The Lead Internal Verifier should fit these assignments into the overall plan and know when they will be assessed.
- You may want to adjust the assignment to make it fit your learners' needs and your centre's resources.
- You should think about exactly how the evidence is going to be produced and whether or not your learners need guiding to relevant activity that they have already completed.
- You may need to plan for practical activities to be carried out and recorded.

It is important that you are as familiar with the endorsed assignment as you would be if you had created it yourself. Understanding the assignment will ensure that you plan activities that properly reflect the scenario given in the assignment, and that you get no nasty 'surprises' when learners' evidence is submitted.

The scenario

The assignment should be set in a vocational context that helps your learners to show what they have learned in a relevant way. This can often be achieved by asking learners to imagine they are in an appropriate job setting with a job role and job tasks. It could involve providing them with a brief of an activity that would be of value to a local employer, or without using a job context directly. It could draw on a real case study in order to allow application and analysis. You can draw on understanding of your sector to develop appropriate assessment contexts.

Evidence

You can choose suitable forms of evidence – it is possible to use a wide range of forms, from reports to presentations, from performances to diaries, from record sheets to video recordings.

Of course you should match the evidence type(s) selected to the requirements of the unit(s) or learning aims(s). For example, if a learning aim requires a practical demonstration then you should think about how that is going to be set up and recorded.

Be careful not to suggest a type of evidence that may be too short – for example, a 'leaflet for new buyers' may be a realistic form of assessment for business learners to produce, but may not provide for sufficient breadth in itself, depending on the assessment requirements.

For some evidence, the period for its production must be time-constrained and, in some cases, you may want to ensure authenticity by having some evidence produced in supervised conditions.

The tasks

The tasks should be a clear statement of what a learner needs to do to produce the evidence. You may explain the tasks to learners in more detail during delivery, but the assignment itself should be clear. You should remember to relate tasks to the scenario and to the evidence. If learners have been carrying out preparatory work – such as visits, rehearsals or skills exercises – then you may want to refer to this in the tasks.

Your tasks must:

- specify the nature and extent of the evidence
- be clear and include any specific materials or steps with times or dates when necessary
- refer to the assessment criteria that the evidence will be judged against
- encourage the generation of evidence that can be judged against the criteria
- be presented in a way the learner can understand – remember that the criteria are not in themselves tasks
- fit together to cover the learning aim sensibly allowing learners to achieve to the best of their ability.

You must make sure that the tasks can generate evidence which cover the criteria. When you create tasks you should not use the exact wording of the criteria, but you should pay close attention to it and the associated assessment guidance

You should always list the criteria covered by each assignment – and also normally each task. When you quote the assessment criteria, please don't change their wording. You can, of course, use a glossary of the wording of tasks to highlight what certain words mean. Many words will be repeated across criteria for different grades and your learners may find it useful if you highlight the changes.

You should remember that the criteria are used to judge the evidence, so completion of a task related to identified criteria does not automatically imply achievement.

Scope

You can choose the scope of an assignment provided that it fits well into the overall assessment plan for the unit(s) and the programme. For some qualifications it is normal practice to bring several units together for large-scale projects, while for others initial coverage of a topic in one unit may then be picked up in later, more specialist units.

When planning a unit-by-unit approach to assessment, you should make sure that learners understand through their learning how the units relate to each other, and that the requirements for synopticity are addressed.

Assignments that span several units should be controlled carefully and you also need to consider whether it is only the learning or both learning and assessment that should be considered.

If you assess a learning aim several times using different assignments then you, as part of the programme team, and the learners must be aware of when the summative grade can be given, and from what evidence. There is never any 'averaging' of achievement or 'aggregating' of separate decisions – a single decision should be reached based on the relevant evidence.

Learner responsibility

You should make sure that learners know they must meet their deadlines and provide work that is genuinely their own, otherwise their grades will be affected. To support learners, you should explain how to reference the work of others and how to work in such a way that ensures they can declare that their work is their own.

We recommend that learners are given a guide to their assessment at induction to the programme. You can reinforce the expectations when assessed assignments are handed out.

Quality assurance

What is quality assurance?

Quality assurance is at the heart of vocational qualifications. For many BTEC units, assessment is completed by your centre and your centre is responsible for the grading and standard of assessments.

- You use quality assurance to ensure that your managers, internal verifiers and assessors are standardised and supported.
- We use quality assurance to check that all centres are working to national standards. This is done by sampling your marked assignments.

What is the purpose of quality assurance?

In your centre, quality assurance allows you to monitor and support your BTEC staff and to ensure that they understand, and are working to, national standards. It gives us the opportunity to identify and provide support where it is needed in order to safeguard certification. It also allows us to recognise and support good practice.

How does it work?

First of all, you need approval to deliver BTEC qualifications. By signing the approval declaration you confirm that you have in place all necessary resources, appropriately experienced staff, quality assurance policies and procedures. You should have standardised systems and procedures for registering and certificating learners, tracking learner achievement and monitoring assessment and internal verification.

During the delivery of a programme, internal verification is the quality assurance system that you use to monitor assessment practice and decisions, ensuring that:

- assessment is consistent across the programme
- assessment tools are fit for purpose
- assessment decisions judge learner work accurately using assessment criteria
- standardisation of assessors takes place.

Internal verification is a recorded discussion between two or more professionals to ensure accuracy, fairness, consistency and quality of assessment. Internal verification procedures must:

- check all the assignment briefs or assessment tools used in every internally assessed unit
- check a sample of assessment decisions made for every internally assessed unit
- check a sample of assessment decisions from every assessor
- ensure that within the sample:
  - the range of assessment decisions made is covered
  - the experience of the assessor is taken into account when setting the sample size
  - the sample size is sufficient to assure the accuracy of the assessment decisions for the whole group
- plan and document the process.

Our external quality assurance processes include:

- annual visits to each centre to look at quality assurance systems and procedures (Quality Review and Development)

- standards verification by a subject specialist to sample assessment and internal verification of learner work
- standardisation activities to support assessors, internal verifiers and lead internal verifiers.

Every year we publish an updated *BTEC Quality Assurance Handbook* to explain our external quality assurance process for the next academic year. Along with the programme specification, the handbook should provide your programme team with everything they need to run vocational programmes successfully.

Centre roles and responsibilities

- **Senior Managers**
  The Head of Centre is formally responsible for ensuring that your centre acts in accordance with our terms and conditions of approval. These include ensuring the provision of appropriate resources, recruiting learners with integrity, providing full and fair access to assessment, maintaining full and accurate records of assessment, complying with all quality assurance processes and ensuring that all certification claims are secure and accurate. Day-to-day responsibility is normally delegated to the centre's BTEC Quality Nominee.
- **BTEC Quality Nominee**
  Each centre is asked to identify a member of staff as its Quality Nominee for BTEC provision. This person is the main point of contact for information relating to quality assurance. Quality Nominees will receive regular information from us about all aspects of BTECs, which they should share with the relevant staff in their centre. Therefore, it is very important that Quality Nominee details are kept up to date on Edexcel Online. We recommend that your Quality Nominee is someone with responsibility for the BTEC curriculum because they will be involved in monitoring and supporting staff in your centre. The Quality Nominee should ensure that BTEC programmes are managed effectively and actively encourage and promote good practice in your centre.
- **Examinations Officer**
  The Examinations Officer is the person designated by the centre to take responsibility for the correct administration of Pearson learners. This person normally acts as the administrator for Edexcel Online – our system for providing direct access to learner administration, external reports and standardisation materials.
- **BTEC Programme Leader**
  The Programme Leader (or Programme Manager) is the person designated by your centre to take overall responsibility for the effective delivery and assessment of a BTEC programme. The Programme Leader may also act as the Lead Internal Verifier.
- **Lead Internal Verifier**
  The Lead Internal Verifier is the person designated by your centre to act as the sign-off point for the assessment and internal verification of programmes within a principal subject area (for example, BTEC Firsts and Nationals in Business, or BTEC Firsts and Level 1 in Engineering). We provide Lead Internal Verifiers with access to standardisation materials. The Lead Internal Verifier should be someone with the authority to oversee assessment outcomes. Ideally this would be the Programme Leader, because this would normally be a key part of their role. They should be directly involved in the assessment and delivery of programmes and able to coordinate across Assessors and other Internal Verifiers for a principal subject area.
- **Assessors and Internal Verifiers**
  The *programme team* consists of the teachers who are responsible for the delivery, assessment and internal verification of the BTEC qualification. An *assessor* is anyone responsible for the assessment of learners. An *internal verifier* can be anyone involved

in the delivery and assessment of the programme. Please note if a teacher writes an assignment they cannot internally verify it. Someone else should perform this function. Where there is a team of assessors, it is good practice for all to be involved in internally verifying each other. If there is only one main person responsible for delivery and assessment then arrangements must be made for their assignments and assessment decisions to be internally verified by someone appropriately experienced.

Tips for successful BTEC quality assurance

- Recruit with integrity. Ensure that the learners you register on the programme are able to achieve at level 2 and have a specific interest in the vocational sector.
- Ensure that you have sufficiently qualified and vocationally experienced staff involved in delivery and assessment. BTECs are vocational qualifications, designed to be delivered by staff with expertise in their subject.
- Provide induction, training and ongoing development opportunities for your staff. Best practice comes from having staff that understand the BTEC ethos and assessment methodology and have up-to-date knowledge of their vocational sector.
- Use the free resources available. There is a wealth of guidance in the specifications and delivery guides that will help you with delivery and assessment.
- Make quality assurance part of everyone's role. Quality assurance is a fundamental aspect of every role, from assessor to senior manager. Recognising this and providing time and resources to support quality assurance is the key to success.
- Plan ahead. You should begin a programme with a clear schedule for handing out assignments, assessment deadlines and internal verification, so that you are well prepared to ensure ongoing quality and able to address any issues quickly.
- Ensure good communication. Assessors, Internal Verifiers, Lead Internal Verifiers and managers should all be clear on their roles and how they interact. The Lead Internal Verifier must have a clear overview of the plan of assessment and how it is being put into practice.
- Provide clear, consistent feedback to learners during the guided learning stage. Give clear and accurate assessment feedback based on the grading criteria only after the final submission. Remember care must be taken to maintain the independence of the learner during assessment activities. This allows learners to know exactly how they are achieving on the programme, identifies areas for development, and encourages them to take responsibility for their own learning.
- Undertake internal verification in a timely way. Assignment briefs must be internally verified before they are given to learners. A sample of assessment decisions should be internally verified as soon after assessment as possible to ensure that learners receive accurate and supportive feedback on their achievement.
- Track assessment and internal verification accurately as you go along. Assessment records should be kept at the level of the learning aim and assessment criterion/criteria. This gives a clear confirmation of individual achievement and identifies areas for improvement.
- Using standardised templates for all quality assurance documents helps to ensure a consistent approach. We provide templates (via our website) that you can use for:
  - internal verification of assignment briefs
  - internal verification of assessment decisions
  - observation records and witness statements.

- These templates are not mandatory and you are free to design your own, but using them will help to ensure that you are meeting requirements.
- Ensure that learner work is kept secure but is accessible during the programme. You will be required to provide learner work for external quality assurance while learners are on programme.

Units

Unit 1: Principles of Science

Delivery guidance

Approaching the unit

This is an externally assessed unit where access to a laboratory is essential. This unit includes knowledge and understanding that is required by learners in Units 2-4. As a result there are two basic ways to deliver the unit:

- As a stand alone unit at the beginning of the course
- Integrated with Units 2-4, so the relevant learning aims for Unit 1 are covered with associated learning aims in an internally assessed unit (e.g. the chemistry in Unit 1 with the chemistry in Unit 2).

The second approach can provide a more coherent learning experience for the learner, although you will need to ensure they are clear on which content is to be externally assessed. Whichever route you take to delivery, please note that early entry to the external assessment does not suit all learners, and so you will need to take a view on their likely readiness if entering them early in their study.

Delivering the learning aims

For **learning aim A**, learners should:

- explore the structure, function and adaptations of eukaryotic cells
- understand the functions of cell organelles
- understand the molecular structure of DNA
- explain chromosome structure and function
- understand the organisational structure of living organisms, illustrated by the cardiovascular system
- understand the function of plant organs.

Learners ideally need access to suitable microscopes and prepared slides to compare eukaryotic cells. If possible you should make suitable electron micrographs available to allow learners to understand the internal structure of a typical eukaryotic cell. Also, learners should be given access to appropriate microscopes and prepared slides, to compare root cells, xylem and phloem vessels.

Learners could:

- do a practical activity demonstrating monohybrid inheritance, (for example, using fruit flies or corn on the cob)
- use Punnett squares and genetic diagrams to display results
- use case studies of genetic diagrams and pedigree analysis to explain the determination of genotypes and phenotypes of offspring.

For **learning aim B**, learners should:

- understand homeostasis and the role of the nervous and endocrine systems
- consider the speed of response of the nervous and endocrine systems and the reasons for the differences (limit examples to blood glucose regulation and thermoregulation)
- explain the gross structure and function of the nervous system (CNS, PNS)

- distinguish between involuntary and voluntary responses
- understand the basic structure of the synapse, the associated electrical impulse and chemical transmission (i.e. neurotransmitters)
- study a simple reflex arc (simple practical activities could be used for demonstration)
- discuss the basic structure of the endocrine system, mentioning associated glands and target organs (you can give several examples of hormones and their functions but learners do not need to know all the functions of hormones secreted by endocrine glands).

For **learning aim C**, learners should:

- develop an understanding of some basic concepts of chemistry
- be introduced to elements as substances which cannot be broken down into anything simpler
- learn that the periodic table contains the names and symbols of all the elements
- draw diagrams of atoms and isotopes
- relate atomic structure and filling of electron shells to position in the periodic table.

For **learning aim D**, learners should:

- investigate the differences between elements, compounds and mixtures, carrying out practical work (for example, distilling salt water, making and separating mixtures of iron and sulfur, making magnesium oxide)
- carry out neutralisation reactions, metal/acid reactions and carbonate/acid reactions
- applications of neutralisation reactions
- carry out pH tests and tests for gases produced in these reactions
- apply their understanding to applications in the manufacturing or service-science industry
- write word and balanced equations for these reactions
- develop practical investigative skills.

For **learning aim E**, learners should:

- develop an understanding of energy forms (for example, thermal, electrical)
- explore energy stores (for example, chemical, kinetic)
- understand energy transfers (for example, conduction, convection)
- explain energy transformations (for example, potential to kinetic),

with follow-up discussions on their applications. Some of the content of this learning aim can be demonstrated effectively through practical work. As this is being carried out, learners can be prepared for measuring energy transfer and its efficiency. This will involve using formulae either by analysing their own work or data given to them. Finally, learners could research sources of renewable/non-renewable energies and their effectiveness.

For **learning aim F**, learners should:

- explore wave characteristics through demonstrations or simulations
- learn and use wave calculations
- demonstrate or investigate practically the electromagnetic spectrum and its uses (with special emphasis on practical uses)
- research and discuss the consequences of exposure to electromagnetic radiation.

Getting started

This provides you with a starting place for one way of delivering the unit, based around the suggested assignments and tasks in the specification.

Unit 1: Principles of Science
Introduction This unit introduces the learners to the key concepts found in biology, chemistry and physics. It should provide learners with knowledge which they can develop through studying the other units that are covered in the *Principles of Applied Science* award.
Learning aim A: Explore cells, organs and genes
Activities in preparation for assessment part 1: The life of cells
You should revise the structure and function of plant and animal cells. Learners could make use of card-matching activities to link the names of organelles with their associated function. Practical activities can be used to reinforce this work. The preparation of non-permanent microscope slides can be used to show the basic structure of plant and animal cells (for example, onion epithelial cells and human cheek cells) as seen under an optical microscope. The use of prepared microscope slides should be used to distinguish between the different types of cells as listed in the unit content. This will allow learners to make comparisons between plant cells and animal cells. The comparison of structures within plant cells and animal cells could be further extended by learners matching the structures of plant cells and animal cells with the relevant functions of the organelles. Further to this, learners should prepare a microscope slide to show the cross-section of a typical leaf structure. Learners can use this prepared slide to identify the components of the leaf and explain the functions of each part. You and your learners should revise the organisational features of the human body. Learners should be able to apply these organisational features to the cardiovascular system. You should discuss the structure and function of DNA. Learners could construct a model of the double helix of DNA. Learners should discuss the components of DNA molecules and understand the roles of bases, genes, proteins and chromosomes. You could show monohybrid inheritance in fruit flies or corn cobs. Through the practical activity, learners could apply terminology such as alleles, genotypes, phenotypes, homozygous and heterozygous. This practical should also provide learners with the opportunity to look at the probability, percentage or ratio of offspring displaying inherited characteristics. Learners should use Punnett squares and genetic diagrams to understand monohybrid inheritance. Examples could include: ● inheritance of the colour of flowers in sweet pea plants ● inheritance of eye colour in humans ● inheritance of the tongue-rolling gene.
Learning aim B: Explore the roles of the nervous and endocrine systems in homeostasis and communication
Activities in preparation for assessment part 2: Communication in the body
● Through discussion and practical exploration, learners should investigate the role of the endocrine and nervous systems in homeostasis. ● Learners could determine the sensitivity of various parts of the body practically – for example sole of foot, fingertips, forearm, lips and forehead. ● Learners could link the structure of the nervous system with the findings of the investigation. For example, they could use the practical as a tool to explain the

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structures and functions of the nervous system and to discuss the difference between voluntary and involuntary responses. An extension activity could allow learners to describe the reflex arc. ● You should revise with learners the interrelationship between the nervous and the endocrine system. ● Learners could use ICT facilities to investigate the differences in communication between the nervous and endocrine systems – for example speed of communication, method of transport or transmission, and duration of response. Learners could create a short poster presentation on the differences identified. ● Through practical activity learners should investigate the effect of exercise on the regulation of body temperature. This would allow learners to discuss the relationship between the nervous and the endocrine systems. ● Using appropriate resources learners could produce a group presentation on the role of the endocrine system in the regulation of blood glucose levels.
Learning aim C: Explore atomic structure and the periodic table
Activities in preparation for assessment part 3: Understanding the periodic table.
● Introduce the periodic table to the learners – they should all have their own copy to work with. ● Learners could write the group names and numbers, and number the periods on their table. They could shade in the metals and non-metals in different colours. ● Learners could research the properties of elements to show that elements in the same group have similar properties. ● You should introduce atomic structure. Protons, neutrons and electrons should be defined and the structure of the atom described. ● Define atomic number, mass number and relative atomic mass. Learners should work out the numbers of protons, neutrons and electrons from an element's atomic number and mass number. ● Learners could draw diagrams of the atomic structures of the first 20 elements. Learners could investigate the meaning of isotopes and explain the difference between some given examples – say C-12 and C-14. ● Learners should use their knowledge of atomic structure and the periodic table to write the electronic configurations of the first 20 elements, and use electronic configuration to predict the group to which an element belongs.
Learning aim D: Explore substances and chemical reactions
Activities in preparation for assessment part 4: Exploring chemical reactions
● Elements, compounds and mixtures should be introduced and definitions given. Diagrams/photographs should be shown of each. ● Learners should carry out practical work on the physical properties of a circus of elements, mixtures and compounds – including conductivity, boiling point, melting point and state of matter. ● Word equations and balanced equations should be introduced. Simple examples should be given. ● You should introduce the learners to acids, bases and alkalis. Learners should carry out practical work on neutralisation reactions using hydrochloric acid, nitric acid and sulfuric acid with copper oxide or zinc oxide, and with sodium hydroxide. ● Learners should carry out metal/acid reactions and test for hydrogen. ● Learners should carry out acid/carbonate reactions and test for carbon dioxide

Unit 1: Principles of Science

- Learners should carry out tests for pH using universal indicator and litmus – they could do these on the reactants and products of the previous experiments.
- Learners could research the hazard symbols for all the chemicals used in this unit.
- Learners could research applications of neutralisation reactions.
- Learners should practise writing the formulae for all the reagents in this unit.
- Learners could practise writing word equations and balanced equations for all the tests carried out. They may need considerable help with this. (This links to *Unit 2*.)

Learning aim E: Explore the importance of energy stores, energy transfers and energy transformations

Activities in preparation for assessment part 5: Energy – where does it come from?

- As part of a general introduction to energy, learners could use a brain-storming session about energy and develop a mind map connecting forms of energy, energy sources, energy transformations etc. This could be a small-group activity leading to contributions and an overall class picture. Homework could be given as a research of sources of energy (renewable/non-renewable) and using energy sources effectively.
- A circus of practical experiments could be set up with learners spending time at each; they carry out the instructions given and use worksheets to answer questions. The circus of experiments can be used to show the following ideas:
  - o different forms of energy
  - o energy stores
  - o energy transformations
  - o energy transfers.
- It may be possible to use one or two sets of experiments to cover the content – use your own judgement to give learners the maximum experience of energy. You could then use discussion time to summarise the learners' findings.
- Learners do not find it easy to work quantitatively, especially when equations are involved. You should devise an introduction to energy transfer measurements and establish units such as watt, joule and seconds. The introduction of diagrams to represent energy transfer and its dissipation would help the learners to visualise this area of work.
- If possible, use the learners' results from their practical work plus other data, if needed, to use the following equation:

$$\text{power (W)} = \frac{\text{energy (J)}}{\text{time (s)}}$$

- You should make sure the calculations are made relevant – give them a vocational setting rather than just a set of numbers to put into a formula.
- Introduce learners to the meaning of energy efficiency and make sure they understand how to use percentages. Again, any such work should be made as relevant as possible.
- A group discussion could be held on efficiency regarding energy transformations and transfers. You could refer back to the circus of experiments to make it relevant or ask the learners to think of examples they are familiar with.
- Your input about how to calculate efficiency will probably be required – this could be as a formal tutorial because it involves using:

$$\text{efficiency} = \frac{\text{useful energy (J)}}{\text{total energy supplied (J)}} \times 100\%$$

  Most learners will need to be led through how to use the formula, but having some data ready for the more able to use while others receive more help will minimise boredom if the pace is slow.

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- Figures from the practical work carried out previously could be used to supply data for the efficiency formula (if experiments had been carefully set up and worksheets had the correct questions).
- Homework could be set on the sources and storage of energy. Learners should be given some direction about the major areas to research (using those listed in the specification), otherwise they could be overwhelmed with the amount and variety of information available.

Learning aim F: Explore the properties and applications of waves in the electromagnetic spectrum

Activities in preparation for assessment part 6: Here come the waves

- An introduction to the electromagnetic spectrum using a presentation and a demonstration of wave characteristics (ripple tanks or simulation) will engage the learners' interest in this topic. During these demonstrations or simulations the units used for stating wave characteristics can be introduced.
- A question sheet could be given out for the learners to complete for homework. The purpose of this would be to check their understanding of wave characteristics.
- You should introduce wave calculations using demonstrations or practical work collecting data to put into the formula:

  wave speed (m/s) = wavelength (m) × frequency (Hz)
- Again, you should have some worked examples for the learners to look through and data for the more able to use, while you spend more time with those who struggle with equations.
- Homework can be in the form of further calculations, using secondary data to make sure the answers are expressed in standard form. Discussion of the homework in the next session will help to make sure that all the learners have understood how to use the equation.
- Most learners are interested in the electromagnetic (EM) spectrum, especially if it is presented visually. You could start this work by looking at how the EM spectrum is used in everyday life. A good way would be for a white board to be made available, on which learners could write their ideas and suggestions and then group them. You could help the learners to divide the ideas into those listed in the specification. This shows the uses of EM radiation in transferring energy and it leads neatly on to the EM spectrum and a more theoretical consideration of EM radiation.
- Most of the uses of EM radiation described will have been positive, but some learners may have pointed out that ultraviolet radiation from the Sun can be harmful, and that infrared radiation burns the skin. This could be used as a starting point for looking at the harm that exposure to EM radiation can cause.
- An interesting homework topic is to ask the learners to construct a chart about EM radiation along with its good and bad points.

Details of links to other BTEC units and qualifications, and to other relevant units / qualifications

- The BTEC Applied Science suite:
  - *Unit 2: Chemistry and Our Earth*
  - *Unit 3: Energy and Our Universe*
  - *Unit 4: Biology and Our Environment*

Resources

Textbooks

In addition to the resources listed below and books designed to cover GCSE Science knowledge, publishers are likely to produce Pearson-endorsed textbooks that support this unit of the BTEC First in Principles of Science. Check the website (www.edexcel.com/resources) for more information as titles achieve endorsement.

Goodfellow, D., Hocking, S. and Musa, I., *BTEC First Principles of Applied Science Student Book*, Pearson Education, 2012 (ISBN 978-1-4469-0279-0)

Hutchings, K., *Classic Chemistry Experiments*, The Royal Society of Chemistry, 2000 (ISBN 978-0-854-04919-6)

Journals

Big Picture Science
A one-hour radio magazine and podcast that examines life and technology on this planet... and beyond.

Focus
A monthly science magazine produced by the BBC, with articles that will stimulate and inspire learners.

New Scientist
A weekly science and technology magazine with diverse subject matter.

Websites

www.ase.org.uk
The ASE is a community of teachers, technicians and other professionals supporting science education.

www.bbc.co.uk/schools/gcsebitesize/science/edexcel/patterns
The periodic table

www.bbc.co.uk/schools/gcsebitesize/science/edexcel/chemicalreactions
Reactions in chemistry

http://www.bbc.co.uk/schools/gcsebitesize/science/edexcel/classification_inheritance/
Online resources for classification, inheritance and variation.

http://www.bbc.co.uk/schools/gcsebitesize/science/edexcel/responses_to_environment/
Online teaching for homeostasis and the nervous system.

www.cellsalive.com
Interactive illustrations for plant and animal cell biology.

www.gcse.com/energy.htm
Suitable for learners and teachers; extensive relevant information clearly set out under easily accessible headings.

http://health.howstuffworks.com/adam-200092.htm
An animation about homeostasis

www.iop.org
Suitable for teachers only; use the teacher links to lesson plans and approaches to different topics.

http://www.nuffieldfoundation.org/practical-biology
http://www.nuffieldfoundation.org/practical-chemistry
http://www.nuffieldfoundation.org/practical-physics
These websites cover the content of this unit for teachers and have practical experimental details and some theory work.

www.rsc.org
Royal Society of Chemistry

www.schoolscience.co.uk
Information relevant to the topics in the unit; teachers should access this site before use by the learner.

www.sciencemuseum.org.uk
Teaching resources for genetics, useful in the classroom.

www.societyofbiology.org
Online resources for learning about DNA.

www.webelements.com
A detailed periodic table

www.whynotchemeng.com/teachers/top%20ten%20flash%20bang%20demos.aspx
Ten demonstrations that can be done in front of the class, including instruction sheets and videos.

Unit 2: Chemistry and Our Earth

Delivery guidance

Approaching the unit

This unit requires the learner to approach many of the concepts through scientific investigation wherever possible. They should have access to laboratory and computer facilities so that they can carry out practical work, access simulations and carry out research using the internet.

Delivering the learning aims

For **learning aim A**, learners could:

- watch demonstrations of alkali metals reacting with water
- carry out displacement reactions of halogens to deduce the relative reactivity of the elements in groups 1 and 7, and explain it in terms of electronic arrangement
- know the importance of various types of bonding and how this affects the properties of a chemical
- use interactive, e-learning material to study ionic, covalent and metallic bonding
- draw diagrams to show understanding of the types of bonding – it is appropriate to carry out practical work in order to learn the behaviour and characteristics of ionic and covalent compounds
- carry out a model-making investigation on the shapes of both ionic and covalent chemicals.

For **learning aim B**, learners could:

- investigate particular examples – such as the use of calcium in the extraction of other metals from their ores; argon as an inert shield in welding; sodium azide in airbags; silicon in computer-chip technology; carbon dioxide in fire extinguishers
- identify the difference between using an element and using its compounds, noting that certain uses are based on physical rather than chemical properties.

For **learning aim C**, learners could:

- carry out investigations on factors affecting rates – such as the reaction of marble chips with an acid, investigating particle size and concentration; the reaction of sodium thiosulphate solution with an acid, investigating temperature; the decomposition of hydrogen peroxide in the presence of different transition metal oxides, potato and liver introduces catalysts; the volume of carbon dioxide produced by the reaction of marble chips with an acid as a function of time providing data for plotting a rate graph
- develop the concepts of word equations and simple balanced symbol equations for the reactions involved in these investigations and as part of learning aim B
- use specific examples to introduce the 'green chemistry' concept of atom economy.

For **learning aim D**, learners could:

- address the environmental effects of both human and natural factors related to a local industry, amenity or something of interest to the learner – such as the extraction of resources from the air and from land; the contamination of land as a result of industrial activity; global warming; ozone depletion

- take part in discussions, or produce presentations, about topics of interest – such as natural factors, like volcanic eruptions and the movement of tectonic plates, that have had a huge influence on the surface and atmosphere of the Earth. Learners should study a topic affecting at least two such factors.

Getting started

This provides you with a starting place for one way of delivering the unit, based around the suggested assignments and tasks in the specification.

Unit 2: Chemistry and Our Earth
Introduction The teaching of this unit should cover both physical and chemical properties, bonding and rates of reaction. Learners should also investigate the factors that affect the Earth and the environment.
Learning aim A: Investigate chemical reactivity and bonding
• You should introduce the periodic table and the trends in the table. Learners should be given their own periodic table to work on. They can label the groups and colour in the metals and non-metals. Learners could carry out practical work on the trends in the periodic table, including the reactivity of the alkali metals and the halides. • Learners should watch a demonstration of the reactions of alkali metals with water. They could note the physical properties such as state, colour and hardness. The demonstration should include testing the gas given off as hydrogen, and testing the solution formed as alkaline. • They could carry out practical work on the properties and reactivity of group 7 elements. They could investigate physical properties such as state and colour. They can carry out displacement reactions to put the halogens in order of reactivity. • They can add arrows to their periodic table showing the order of reactivity for the alkali metals and for the halogens. • Reactivity should be discussed in terms of electronic arrangement and shielding. • A visit to a chemical company that manufactures products or a visiting speaker would help to put this topic in perspective. • The different types of bonding (ionic, covalent, metallic) should be introduced. Learners could investigate the different types of bonding using interactive e-learning material. • They could carry out practical work measuring electrical conductivity, solubility, melting point and boiling point to compare covalent and ionic substances. They can put their results in a table to compare compounds with the two types of bonds (links to *Assignment 2*). • Learners could make models to show shapes of ionic substances (for example sodium chloride, magnesium oxide, magnesium chloride) and covalent substances (for example hydrogen, chlorine carbon dioxide, methane, water, oxygen). • They could draw dot-and-cross diagrams to show understanding of the different types of bonding. • You should discuss the relationship between structure and properties with the learners, and relate this to the practical work carried out on the properties of ionic and covalent compounds and to the models built and diagrams drawn.
Assignment 1: Manufacture and Quality Control of Compounds*
Learning aim B: Investigate how the uses of chemical substances depend on their chemical and physical properties
• Revise chemical changes and physical changes with the learners. Explain how to recognise a chemical change and a physical change – you could give some examples. The learners could be asked to suggest some examples of their own. • Learners carry out practical work investigating physical and chemical changes. They

Unit 2: Chemistry and Our Earth

can melt ice and boil water and then reverse the changes. They can burn fuel to show that new products formed. Flash cards showing changes could be used for the learners to sort into physical or chemical.

- Learners should investigate chemical substances related to an industry (for example, silicon in the computer industry), or a use (for example, sodium azide in airbags). This can be done through research on the internet. You will need to guide the learners to ensure that they are finding correct information. This could be set as homework and learners could make a presentation of their findings.
- Learners should use the practical work measuring electrical conductivity, solubility, melting point and boiling point to compare covalent and ionic substances (links to *Assignment 1, Part B)* and to link the uses of chemicals to their physical properties. They could produce a poster showing how uses are linked to properties. You could ask the more able to consider how the use of a chemical is based on both physical and chemical properties.

Assignment 2: Useful Chemical Products*

Learning aim C: Investigate the factors involved in the rate of chemical reactions

- A visit to a chemical company that manufactures products or a visit from a research chemist or plant chemist would help to put this topic in perspective.
- Revise word equations. Describe simple reactions and allow learners to write the word equations from the description.
- Show examples of writing balanced equations. Learners can use models to show how there are the same number and types of atoms on both sides of the reaction. They can write their own equations based on the work with the models. Learners should have the opportunity to practise writing word equations and balanced equations. They may need considerable help with this.
- You should give examples of displacement, combustion and neutralisation reactions. These should be drawn from work within this unit or earlier units. Learners should be asked to identify the reactants in and the products of the reactions they have seen or have carried out.
- You could heat blue copper sulphate crystals, and then add water to the white anhydrous product to show an example of a reversible reaction.
- You could introduce rates of reaction by showing three different reactions working at different rates – for example, an iron nail rusting in water, an indigestion tablet fizzing in water, a balloon full of hydrogen being ignited.
- The factors affecting rate of reaction could be introduced and learners could carry out practical work on rates of reaction looking at temperature, concentration, surface area (particle size) and catalysts. There is a range of investigations suitable for these. The following are some suggestions but it is not a comprehensive list:
  - learners could research the reaction of magnesium with hydrochloric acid – temperature, surface area, concentration
  - learners could research the reaction of sodium thiosulphate solution with hydrochloric acid – temperature, surface area, concentration
  - learners could research the catalytic decomposition of hydrogen peroxide using manganese (IV) oxide – catalyst (this can also be done with potato or liver providing the catalyst)
  - learners should use reaction rate graphs – they should explain what is happening, using collision theory; they may use simulations to investigate what is happening
  - learners could investigate some industrial reactions to consider yield and atom economy – they could make a presentation or produce a report on the Haber process.

Unit 2: Chemistry and Our Earth
Assignment 3: Controlling Industrial Reactions*
Learning aim D: Understand the factors that are affecting the Earth and its environment
● A visit to an environmental centre or a visit from an environmental scientist would help to put this topic in perspective. ● There should be some formal teaching of the ways in which the Earth can be affected by man and natural phenomena. This should cover tectonic plates, volcanoes, burning fuels and the extractive industries. Learners could be given one of the above and be asked to research the effects and then to present back to the group. There is extensive information on the internet, so you will need to ensure that clear guidance is given to focus the learners. There have been many recent examples of natural phenomena, such as the Japan tsunami and earthquake, and the earthquake in Christchurch. There are news footage and newspaper articles available that can stimulate discussion and interest in this context. ● A debate lesson could be used to look at the benefits and disadvantages of, for example, the use of natural resources, chemical processing, and obtaining natural materials. ● Practical work could be carried out on the ways that man has changed the environment, including the effect of acid rain on rocks and the production of gases during combustion. ● Learners could be asked to write an article describing sustainable development issues. They could look at human choices and human solutions to problems. They will need access to the internet and other resources. Again, you should offer considerable guidance.
Assignment 4: Affecting the Environment*

*Full details for the assignment and scenario can be found in the relevant qualification specification.

Details of links to other BTEC units and qualifications, and to other relevant units / qualifications

- The BTEC Applied Science suite:
  - *Unit 1: Principles of Science*
  - *Unit 5: Applications of Chemical Substances*

Resources

Textbooks

In addition to the resources listed below and books designed to cover GCSE Science knowledge, publishers are likely to produce Pearson-endorsed textbooks that support this unit of the BTEC First in Principles of Science. Check the website (www.edexcel.com/resources) for more information as titles achieve endorsement.

Goodfellow, D., Hocking, S., and Musa, I., *BTEC First Principles of Applied Science Student Book*, Pearson Education, 2012 (ISBN 978-1-4469-0279-0)

Hutchings, K., *Classic Chemistry Experiments*, The Royal Society of Chemistry, 2000 (ISBN 978-0-854-04919-6)

Journals

Focus
A monthly science magazine produced by the BBC with articles that will stimulate and inspire learners.

Materials World
A magazine specifically devoted to the engineering materials cycle, from mining and extraction, through processing and application, to recycling and recovery.

New Scientist
A weekly science and technology magazine with diverse subject matter.

Websites

www.bbc.co.uk/schools/gcsebitesize/science/edexcel/patterns
The periodic table

www.bbc.co.uk/schools/gcsebitesize/science/edexcel/chemicalreactions
Reactions in chemistry

http://www.nuffieldfoundation.org/practical-chemistry
Covers the content of this unit for teachers, giving practical experimental details and theory work.

www.rsc.org
Royal Society of Chemistry

www.whynotchemeng.com/teachers/top%20ten%20flash%20bang%20demos.aspx
Engaging demonstrations for the front of the class – includes instruction sheets and videos.

www.visionlearning.com/library
A library of chemistry resources including simulations of bonding.

Unit 3: Energy and Our Universe

Delivery guidance

Approaching the unit

Give your learners plenty of opportunities to explore this unit by ensuring that they have access to laboratory and computer facilities to carry out practical work, access simulations and carry out research using the internet.

Delivering the learning aims

Learning aim A is concerned with nuclear structure and radioactivity. It is not expected that you will have access to radioactive materials and, therefore, the use of simulations will substitute for practical work for this section. You will need to give an introduction to the subject, and include awareness of health and safety matters in relation to working in a laboratory.

Ideally your learners (with support if necessary) would use computers to become familiar with the appropriate content and assessment criteria. Alternatively an appropriate programme can be used on an interactive whiteboard as a group activity. Whichever way this section is delivered, it should be put into a vocational context, particularly when calculations are required. For example, you could give half-life data, which your learners can put into a graph package and interpret.

The emphasis in **learning aim B** is on practical work and requires laboratory facilities. You may feel that building electrical circuits and beginning to work with calculations should be tackled before the more theoretical work on producing and transmitting electricity. The emphasis should be on using practical work to understand the behaviour of electricity and its transmission. Setting the work in a vocational context prevents it from becoming an exercise in using electrical formulae for no apparent reason. This also applies to electrical transmission, where the emphasis should be on the practical side of generating and transmitting electricity, the costs and the implications of inefficiency of transmission.

Learning aim C tackles the Solar System and space. If you have access to telescopes, planetariums and observatories you will have a wealth of materials at your disposal. If you do not have such facilities, there are numerous online resources.

Learners could:

- build models, and use these for discussions about things such as size and distances – this can introduce your learners to more difficult concepts such as red-shift
- build telescopes in the laboratory using lenses and tubing
- explore the different types of sophisticated instruments being used to study the Universe today
- investigate and experience using different telescopes by using online simulations (for example, robotic telescopes).

Getting started

This provides you with a starting place for one way of delivering the unit, based around the suggested assignments and tasks in the specification.

Unit 3: Energy and Our Universe
Introduction This unit could be introduced by using a series of carefully chosen newspaper, or online, news items – the more controversial the better because this will stimulate interest and conversation. The intention is to capture learners' interest and then focus on radiation and electricity. Where possible, use the evidence from practical work to help the learners achieve the assessment criteria. You should have prepared practical observation sheets for use as the experiments are carried out where evidence of learner work is needed.
Learning aim A: Understand ionising radiation, its uses and sources
• Revise atomic structure with learners so that they can see how and why radioactive materials act in the way they do. An introduction to atomic number and mass number and the symbols used will also help learners to understand the nature of radiation. The suggested websites could be used for this. • The emission of different types of radiation, comparisons of ionising and penetration abilities can be carried out by computer simulations from the websites listed. A card-matching quiz can be used, where learners have to match information about radioactive materials to the correct element and the ability to penetrate substances such as card, paper, lead, etc. • Investigate radioactive decay half-life using simulations, and input data to plot and use half-life graphs. Calculations involving half-life will be needed and some learners may need considerable help with this. • Nuclear fission and nuclear fusion should be discussed with learners in terms of changes in the nuclei. Computer simulations are available from the websites listed. Card-matching quizzes could also be used where the change in the nuclei has to be matched to the type of radiation produced. • Looking at the differences between fission and fusion, as related to nuclear power stations and energy release in stars, is best tackled by directed research and group discussion. There is much information available and you will need to monitor the learners' research so that they do not amass information that does not meet the criteria. • Environmental issues of nuclear power should be discussed and could be used as a homework activity. You could set some specific topics to be researched for homework – such as how to control fission and fusion reactors, the environmental impact of the waste produced and the implications of a leak of radioactive material. Alternatively, the more able learners could be directed to the assessment criteria and carry out their own research. As this is such a big topic, you could give the learners case studies to analyse.
Assignment 1: Do They Always Glow in the Dark?*
Learning aim B: Know how electrical energy produced from different sources can be transferred through the National Grid to homes and industry
• This learning aim could be introduced by using some prepared studies on different views about producing energy. These could be hard copies or the learners could access them on the centre's website (allowing for further study in their own time and at their own pace). Include arguments about the efficiencies and environmental impact of different production methods. Follow this up with group discussions.

Unit 3: Energy and Our Universe

- Review the main ways of producing electrical energy emerging from the earlier introduction. They should include batteries, solar cells, and a.c. and d.c. sources.
- Practical work should be carried out to include:
  - a simple cell made from dilute sulfuric acid, copper and zinc plates
  - Leclanché cell, which learners are familiar with as the dry cell batteries they use (they can be dissected – with care)
  - layer cells
  - lead–acid accumulators, as used in car batteries
  - recharging batteries
  - solar cells.
- Learners do not need to produce detailed accounts of the experimental methods used in their practical work. They should be able to use the information from the practical work to describe how a.c. and d.c. electricity is produced.
- Refer learners back to the prepared studies on the environment and efficiency when generating electricity. Encourage them to use this information and carry out some more research as part of their own study time, so that they can compare the different ways of producing electricity.
- A visit to an energy company or a visiting speaker from an energy company would help to put this topic in context.
- Remind learners of the practical work they did for *Assignment 2 (Part A)* on generating electricity.
- Learners should be able to work practically on using step-up and step-down transformers (refer to Nuffieldfoundation.org/practical-physics – this gives the practical experiments to carry out). Learners should use the results of these experiments to show that they understand how electricity is transmitted to homes and industry. You should also discuss with them any energy 'losses' during transmission. These 'losses' can be followed up as part of private study so that learners can explain qualitatively how energy 'losses' in transmission can be minimised.
- For more able learners, a quantitative approach using equations is required. You will have used equations when doing circuit work, and it will be necessary to reintroduce these equations, perhaps with some worked examples, before learners use them to assess 'losses' in transmission or transformation.
- Remind learners about the work they carried out to build simple series and parallel circuits. When carrying out practical work, learners should be reminded about keeping accurate records. They should be able to show that they can measure current and voltage. Also, the learners must show their calculations from primary and secondary data for:

  $V = IR$; $P = VI$
- You must ensure that the learners can predict values by using $V = IR$.
- Assessment of practical work is required for *Assignment 2 (Part C)*. (You may prefer to do *Part C* before the other parts of *Assignment 2*.)

Assignment 2: Making Electricity – Really!*

Learning aim C: Know the components of the Solar System, the way the Universe is changing and the methods we use to explore space

- A visit to an observatory or a visiting astronomer would help to put this topic in context.
- As an introduction, using visual aids, you and the learners can define the Universe and Solar System and its composition. You should provide guidance because there is so much data available that the learners will probably be overwhelmed and many of

Unit 3: Energy and Our Universe
them unable to decide which material is relevant. This assignment lends itself to model-making and other visual displays without losing the scientific basis of the information needed. ● Card games can be used to match Solar System components and distances. ● You could start a group discussion on how the Universe began. Numerous ideas will arise but, after discussion, you could set learners a homework activity on the Big Bang theory to explain the beginning of the Universe. ● Once the Big Bang theory has been established, it can be used to look at how the Universe is changing. Again, discussion backed up by private study will help learners towards achieving the intended criteria. ● The whole of this unit should be based on practical work centred on the principles of simple telescopes. Simulation packages available on the internet may be used if access to telescopes is not possible. ● You may decide to introduce the idea of an expanding Universe by showing how evidence suggests the galaxies are moving away from us. Practical work and simulations on red-shift can underpin this. Many learners will be familiar with the sound of an ambulance siren and how its pitch changes as it comes towards, and then moves away from the onlooker. This familiar example can be transferred to the red-shift seen in galaxies moving away from us. ● A discussion of the ways of observing the Universe using simulation packages, etc. will help learners to understand the variety of methods, apart from telescopes, that can be used to observe the Universe.
Assignment 3: Where Is All that Space?*

*Full details for the assignment and scenario can be found in the relevant qualification specification.

Details of links to other BTEC units and qualifications, and to other relevant units / qualifications

- The BTEC Applied Science suite:
  - *Unit 1: Principles of Science*
  - *Unit 5: Applications of Chemical Substances*

Details of links to other BTEC units and qualifications, and to other relevant units / qualifications

- The BTEC Applied Science suite:
  - *Unit 1: Principles of Science*
  - *Unit 6: Applications of Physical Science*
  - *Unit 9: Practical Scientific Project*
  - *Unit 17: Using Mathematical Tools in Science*
  - *Unit 20: Exploring Our Universe*
  - *Unit 21: Electronics in Action*
  - *Unit 25: World Energy*

Resources

Textbooks

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Goodfellow, D., Hocking, S., and Musa, I., *BTEC First Principles of Applied Science Student Book*, Pearson Education, 2012 (ISBN 978-1-4469-0279-0)

Websites

www.bbc.co.uk/science/space
A very good website for teachers and learners; visually excellent with concise information.

www.faulkes-telescope.com
The Faulkes Telescope can be controlled by learners over the internet; there is a Moodle Virtual Learning Environment full of training resources and activities for teachers and learners.

www.gcse.com/energy.htm
Suitable for learners and teachers to use, with extensive relevant information set out clearly under easily accessible headings.

www.iop.org
Suitable only for teachers; your links can be used to look at lesson plans and approaches to different topics.

http://www.nuffieldfoundation.org/practical-physics
Covers the content of this unit for teachers, giving practical experimental details and theory work.

www.planetary.org
You should use this site rather than learners; although it is up to date, the articles need to be sorted through to find those that match learning aim C.

www.schoolsobservatory.org.uk
The National Schools' Observatory is an internet-based resource providing learners with access to a fully robotic telescope.

www.schoolscience.co.uk
You should access this site before use by the learner to find information relevant to the topics in the unit.

www.space.com
You should visit first so that you can direct learners to the areas of interest for this unit.

www.telescope.org
The Bradford Robotic Telescope is a free resource; there is also a special subscription site (schools.telescope.org) that supports both learners and teachers.

www.telescope.livjm.ac.uk
The Liverpool Telescope is at Mount Teide in Tenerife and has a live webcam of the telescopes, which can sometimes be remotely controlled from the computer being used; you should access this before learners use it.

Unit 4: Biology and Our Environment

Delivery guidance

Approaching the unit

The unit gives plenty of opportunity for learners to carry out independent research using resources such as press articles, relevant textbooks and ICT. Environmental departments of local councils or conservation groups can be very accommodating in providing materials and guest speakers to enhance teaching. They are eager to encourage a greater awareness in the community of local issues and initiatives such as pollution monitoring, conservation and recycling schemes. Learners may extend their independent work by investigating such schemes, visiting recycling centres or carrying out surveys in school or the local community to collect primary data – this can be used to enrich learning and encourage access to higher grades. Learners may wish to set up their own projects – with guidance – which may involve their peers, or to work alongside volunteers who tackle environmental or conservation issues.

Delivering the learning aims

You can link **learning aim A** and **learning aim B** to cover much of the unit content. This teaching should be divided into shorter tasks, with an investigation that covers the unit content for A.1 to A.5. Some theoretical input supported by examples (which you can give learners or which they can find themselves) would help to guide learners and stimulate discussion and ideas that can be developed within their work. Tasks may incorporate practical work (for example, analysis of water or soil samples) or may involve the collection of data (for example, linking indicator-species distribution with levels of pollution in an area). You could extend this with further tasks that cover the criteria for learning aim B, where much of the investigative work could be focused.

Learning aim C provides opportunity for learners to practise their practical skills within the laboratory – an investigation into the effectiveness of various antibiotics on bacterial growth could be carried out to support their study concerning the treatment of disease. You could supplement work in this area with input from guest speakers who work in the medical profession or environmental health. Many of these professionals are knowledgeable about the prevention of disease transmission and could offer information enabling learners to fulfil the first three learning aim criteria. Some theoretical input is needed to complete learning aim C because learners must understand inheritance patterns before they are able to investigate the inheritance of disease.

This unit requires the learner to approach the concepts through scientific investigation wherever possible.

Getting started

This provides you with a starting place for one way of delivering the unit, based around the suggested assignments and tasks in the specification.

Unit 4: Biology and Our Environment

Introduction

This unit could be introduced using video footage, newspaper articles and/or information leaflets on various species endangered as a result of human activity. The introduction could include a view of the work of the World Wildlife Fund, which is likely to generate discussion and debate related to conservation issues and the reasons for species becoming endangered. It is likely that the interest of most learners will be stimulated more by activities related to endangered animals, although discussion should not be limited to this. Some emphasis should also be placed on other endangered organisms, such as plants and insects, which play an interdependent role in the environment and in the survival of other living things.

Learning aim A: Investigate the relationships that different organisms have with each other and with their environment

- A visit from an environmental officer would help to put this topic into context.
- Sets of cards can be used to match different organisms with their adaptations and their environment, to inform learners of the specific features of living organisms that enable them to survive in particular habitats. One set of cards could have pictures or photographs of different organisms that could then be used later to construct identification keys.
- Short video clips may also be useful in enabling learners to see how specific adaptations of organisms are put to the test in their quest for survival. Learners could investigate the distribution of species, and use cameras to photograph organisms to produce a report of their adaptations and habitats. There is scope to use sampling equipment such as quadrats and pitfall traps, which are useful in determining the number and types of organisms found in various habitats.
- You will need to support learners in their understanding of the influence of genes and the environment on characteristics. More able learners will be expected to show a good understanding of the link between genetic and environmental characteristics and how these are involved in driving the evolution or extinction of species. Particular examples may be given to learners to develop their understanding of the evolutionary process, such as the evolution of the horse or Darwin's finches, the concepts of which they can then apply to other species in the work that they produce. Details of natural selection as part of the evolutionary process will be expected, and learners will also be expected to show some understanding of how gene mutation can bring about evolution. This work would link to part of the content for learning aim C, where they learn about antibiotic-resistant bacteria.
- To help learners develop their own keys, it may be helpful for them to work initially in pairs, or as a whole group, to work through a sorting activity that will encourage the use of a range of different questions that can be used to identify particular objects. For example, pictures of different coins or flags are easily obtainable and will help learners to look at the different features that distinguish each one. Use can be made of the material that the learners have already gathered to construct identification keys, although such keys can be independent of the work already carried out to meet this learning aim. Photographs and pictures can easily be obtained from various websites to enable learners to construct valid keys that distinguish different organisms from each other. Learners should be encouraged to use a range of valid questions in their keys, rather than focusing on a particular feature such as colour. The identification keys

Unit 4: Biology and Our Environment

constructed by learners may be used as classroom displays that could support other teaching groups in their learning.

- The work that learners carry out on interdependence should not be restricted to feeding relationships. The idea of food chains and food webs is a starting point that many learners are likely to be familiar with, but the idea of interdependence in other situations, such as production of oxygen by plants for use by humans or mutualistic relationships, should be explored and incorporated into the work that learners produce. A fun starter activity that encourages all learners to think about feeding relationships is to ask what he or she had for dinner the night before, and to build up a food web from this on the board as a whole-class activity. This could lead into all learners building up their own food webs based on what they, themselves, had eaten. Alternatively, learners could research a particular habitat and construct a presentation to show how organisms within the chosen habitat show interdependence.

Assignment 1: Threat to the Ecosystem*

Learning aim B: Demonstrate an understanding of the effects of human activity on the environment and how these effects can be measured

- You could introduce this learning aim by illustrating the impact that various human activities have on the environment. There are some particularly informative video clips available, such as those in the BBC Learning Zone, that can be used as starter activities to stimulate discussion and set minds thinking about the consequences of destructive human activities. Learners could carry out research on the scale of deforestation over a period of time, and the effect that this has had on local climate change and species survival (referring back to the work completed in *Assignment 1*).
- Learners could link their research to an increase in demand for farmland and agriculture, and to how the use of chemicals such as fertilisers and pesticides has led to pollution of land and the death of organisms. Examples of the effects of such chemicals can be given, such as the massive destruction caused by the post-war use of DDT. This example, in particular, will help learners to understand the bio-accumulative effect that some pesticides can have. Use of extracts from the book *Silent Spring* by Rachel Carson may provide stimulating material, as well as being a literacy activity that learners can use. Learners are likely to need your support in their work on eutrophication and how this process leads to oxygen depletion in waterways. Again, specific examples can be visualised using images, animations or videos from various websites. Learners will be expected to show an understanding of the exact cause of oxygen depletion, and that eutrophication, as a result of excessive fertiliser use, is only the ignition that starts off the series of events leading to the death of aquatic organisms.
- Learners will not be expected to give a detailed account of how transport has led to an increase in pollution, although they should show an understanding of the consequences that an increase in the burning of fuel can have on the environment. Learners will produce work showing evidence that they understand the link between an increase in demand for food and the land to grow crops to an increase in the transporting of food from country to country. Learners should also be aware of the pollution caused by transport used by both the private and business sectors. There is plenty of opportunity to demonstrate mathematical and analytical skills in this context because learners could analyse and evaluate data provided by travel agents and flight companies on how the extent of travel has changed in recent years.
- Learners could be introduced to practical work that involves an investigation of the distribution of indicator species, if the local environment permits. Sampling pond or river water for indicator species or oxygen concentration using probes, or estimating the size of lichen populations at determined locations, provides good evidence of the levels of pollution. If the environment is unsuitable for sampling, learners should be

Unit 4: Biology and Our Environment

given the opportunity to develop their analytical skills using secondary data, either provided for them or obtained using information provided by local government, the environment agency or other sources available on the internet. The local council environmental department may be able to provide a guest speaker who could present information on the work carried out in the local community. Learners could prepare for such an activity by constructing questionnaires based on the criteria for this learning aim.

- Learners are likely to be familiar with local and national government drives on conservation techniques such as recycling. Again, by giving details on their short- and long-term impact on the local environment, the local council can provide information ranging from the reasons why conservation and pollution reduction methods are imposed to their success rate. Learners could set up their own recycling projects involving other members of the school and the local community, although their time should not be entirely focused on this particular technique. More able learners should be encouraged to use questioning or other techniques to extract information that will enable them to evaluate local and national conservation initiatives such as recycling. Clear details of this, including data analysis to support their evaluation, will be evident in the work that they produce.
- It may be possible for learners to visit a local zoo or small animal park to learn about breeding programmes. If this is not possible, learners could be referred back to the work on endangered species carried out for learning aim A, and extend this work to include details about plant and animal conservation breeding programmes, using information obtained from websites. Real-life examples should be included in this work and, if it is not possible to organise a visit, then the websites of many British zoos provide information on the conservation programmes that they run.
- Learners should provide evidence and an argument for and against the use of organic fertilisers and biological pest control, as opposed to traditional methods of growing crops. There are likely to be many organic farmers in the locality who may be prepared to discuss their reasons for organic farming with learners. Learners could carry out work independently on the popularity of organic food and visit local supermarkets to collect information as part of a homework activity. This should be pre-organised, although learners could develop their communication skills by writing or telephoning local companies to request a guided visit.
- The use of solar panels is becoming very popular and any school undergoing a refurbishment or rebuild is likely to have considered this option as a method of generating energy. This would provide an excellent opportunity for learners to speak to members of staff involved in the school design and to find out the reasons for considering this alternative energy resource. Alternatively, companies that specialise in renewable energy resources might be willing to visit the school to give a presentation to learners on the advantages and disadvantages of using renewable energy resources. It is expected that learners will demonstrate some understanding of a variety of renewable energy resources, although they may focus attention on one type of resource to give more detailed information, with less detail given for other resources that have been mentioned in their work. This work could be presented as a report or as a presentation, using information collected first-hand or from research carried out with relevant companies or websites.

Assignment 2: Advising Industry About Impact on Ecosystems*

Learning aim C: Explore the factors that affect human health

- A visit to a hospital pharmaceutical department or a visit by a pharmacist would help to put this topic into context.

Unit 4: Biology and Our Environment

- A presentation, as a starter activity, showing images of various human diseases is very likely to stimulate discussion and interest, although the images used should be chosen carefully. This could lead to a discussion on the causes of disease covering details that could direct learners' thinking towards lifestyle choices such as smoking and misuse of drugs.
- Learners may need guidance on the biological causes of disease, although this work can be carried out independently as part of a research activity. Learners will be expected to know how pathogens disrupt human health, and to be able to describe at least two diseases for each pathogen (viruses and bacteria) and their symptoms. In addition to this, learners could extend their research to cover the influence of carcinogens on health, including the effects of alcohol on the liver and the nervous system. There is opportunity here for learners to develop their mathematical skills by analysing data on the correlation between liver disease and alcohol consumption, or between smoking and lung cancer.
- To understand the effects of diet on health, learners may need theoretical input, either from you or from another qualified professional, for example a dietician, who could provide learners with nutritional information. Learners should be able to link deficiency diseases with a lack of particular nutrients in the diet – for example, scurvy as a result of vitamin C deficiency – but may also focus some of their attention on unbalanced diets leading to disorders such as obesity and the health problems it can cause.
- Learners should be able to show evidence of their understanding of adequate exercise in maintaining good health. Information could be collected through exercise-related surveys constructed by learners, although these should be carefully worded to ensure that relevant and adequate details are obtained from the subjects of the survey. The information collected through surveys could be supported by secondary source data obtained from websites, such as recommended exercise programmes for specific individuals. Learners could conclude their work in this area by devising diet and exercise programmes, or evaluating the appropriateness of the exercise regimes of the people surveyed.
- Some learners will find the concept of inheritance difficult and strategies should be implemented to help them to overcome this challenge and to help more able learners to gain an understanding of pedigree analysis. The use of examples such as the inheritance of cystic fibrosis or sickle cell anaemia, and going through these with the class as a whole, will initially provide some learners with direction – additional support may be provided using worksheets and other resources, such as videos. Learners should become familiar with how some diseases are inherited, with the more able learners identifying dominant and homozygous recessive disorders, giving details in their work on inheritance patterns. Learners may present their work on the causes of disease, including genetic disease and lifestyle, as a presentation or as an information leaflet that could be used by others in helping them to make lifestyle choices.
- Learners should be given the opportunity to develop their practical skills by investigating the effect of different antibiotics on the growth of bacteria. The results of such an investigation should give learners an insight into the use of different antibiotics to treat particular infections. If practical work is inappropriate, learners should have access to secondary data that give the results of similar experimental work. They should use this to carry out an analysis on the effect of antibiotics on bacterial growth and make a conclusion regarding the best use of particular antibiotics to treat infection. Investigative work can lead to discussion about the advantages and disadvantages of widespread antibiotic use and, for more able learners, the rise of antibiotic-resistant bacteria and associated problems.
- All learners will be expected to understand at least one treatment regime used to control infection, with details given on how the use of antibiotics must be guided by professional advice. Learners should also be familiar with disease prevention programmes – namely vaccinations – and how these are carried out in order to prevent

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the spread of disease. Learners may focus their attention on one particular preventative measure, such as the vaccination programmes available for childhood diseases including measles, mumps and rubella, with more able learners extending their work to research the advantages and disadvantages of such programmes. Although the way that learners present this work is flexible, it may be that the information they collect in relation to the prevention and treatment of disease can be included in the work produced earlier on the causes of disease.
Assignment 3: Improving the Use of Medicines*

*Full details for the assignment and scenario can be found in the relevant qualification specification.

Details of links to other BTEC units and qualifications, and to other relevant units / qualifications

- The BTEC Applied Science suite:
  - *Unit 1: Principles of Science*
  - *Unit 7: Health Applications of Life Science*
  - *Unit 8: Scientific Skills*

Resources

Textbooks

In addition to the resources listed below and books designed to cover GCSE Science knowledge, publishers are likely to produce Pearson-endorsed textbooks that support this unit of the BTEC First in Principles of Science. Check the website (www.edexcel.com/resources) for more information as titles achieve endorsement.

Goodfellow, D., Hocking, S. and Musa, I., *BTEC First Principles of Applied Science Student Book*, Pearson Education, 2012 (ISBN 978-1-4469-0279-0)

Websites

http://www.nuffieldfoundation.org/practical-biology
Covers the content of this unit for teachers, giving practical experimental details and theory work.

www.environment-agency.gov.uk
Information and advice on the effects of human activities and pollution on the environment.

www.hpa.org.uk
The Health Protection Agency website gives information on their role to protect the community from infectious diseases.

kidshealth.org/teen/your_body/health_basics/genes_genetic_disorders.html
Learner friendly website containing details about genes and genetic diseases.

www.medicinenet.com/genetic_disease/article.htm
Information on genetic diseases, including cystic fibrosis and sickle cell anaemia.

www.recycling-guide.org.uk
Learner friendly website encouraging recycling, including why it is important and where and how you can do it.

www.talktofrank.com
Drug information and advisory service

www.who.int/mediacentre/factsheets/fs313/en/index.html
The World Health Organisation provides information about air quality and the effect it has on health.

www.who.int/topics/infectious_diseases/factsheets/en/index.html
The World Health Organisation gives key facts, signs and symptoms, prevention and treatment information on infectious diseases.

Annexe

Assessment command words

Most assessment and grading criteria start with a command word – 'describe', 'explain', 'evaluate', etc. These words relate to how complex a learners' answer should be.

Learners will need to provide evidence that meets the command-word requirements of a criterion. For instance if the command word is 'describe' evidence must provide a description in the learner's own words. (A diagram on its own for 'describe' is not sufficient, but a diagram may be used to help aid the description.) Some words in the assessment criteria grids have particular meaning in the science sector. For guidance definitions are given below.

Word	Meaning
Analyse	Examine methodically and in detail, typically in order to interpret.
Assess	Give careful consideration to all the factors or events that apply, and identify which are the most important or relevant.
Calculate	To numerically determine a solution, showing your working out in stages.
Classify	To arrange the subjects in to categories, such as elements or species.
Compare	To contrast the main factors relating to two or more items/situations against each other.
Construct	To make a product following research or instructions from the assessor.
Demonstrate	To carry out practically or show sound knowledge.
Describe	Give a clear series of statements that include all the relevant features (think of it as 'painting a picture with words').
Discuss	Consider different aspects of a topic and how they interrelate and the extent to which they are important.
Distinguish	To recognise and mark the difference between items e.g. plant and animal cells, ionic and covalent compounds.
Draw	Can be used in two ways – either to ask you to draw a diagram, or to produce a graph or table of results. Remember that diagrams of scientific apparatus should be shown as simple line diagrams, not as 3D pictures.
Evaluate	Judge the reliability and validity of a conclusion based upon all of the known evidence. Give evidence for each of your views and for counter arguments.
Explain	Provide detail which shows understanding of a description and give reasons and/or evidence to support the points you are making. Start by introducing the topic then give the 'how' or 'why'.
Identify	Recognise or indicate the main features or purpose of an object.
Justify	Give reasons or evidence to support an opinion.
List	Prepare a series of names, numbers or words e.g. list the types of radiation found in the electromagnetic spectrum.
Predict	Set out what you believe will happen e.g. predict effect that exercise will have on the human body.
Relate	To show a connection between two or more things e.g. the similarities of elements to particular characteristics in a group of the periodic table.

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