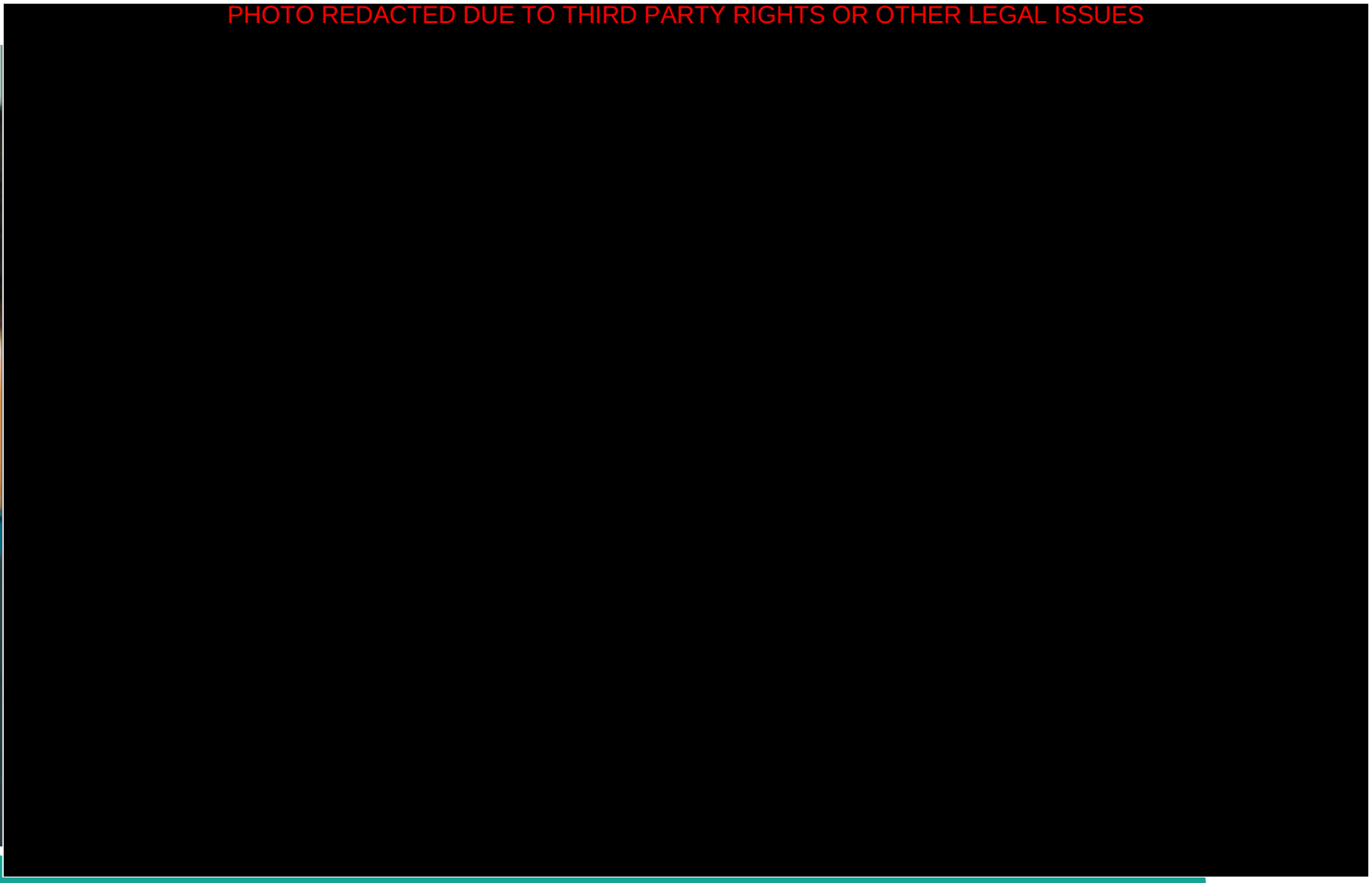
The National Strategies



Learning targets in science

department for
children, schools and families

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Please check all website references carefully to see if they have changed and substitute other references where appropriate.

Contents

00061-2010BKT-EN

1. Introduction

Do your pupils…

- make progress, in relation to learning objectives, with some independence?
- sometimes use their own success criteria to improve?

As a teacher, do you…

- review progress regularly with pupils?
- use skilful questioning, appropriate resources and engaging activities to focus and sustain whole-class and group dialogue?
- have an understanding of standards and progression across the key concepts and skills that informs your planning?

If so, you are ready to take the next step in developing your expertise by developing Learning targets with pupils. Using Learning targets will result in pupils acquiring an appetite for learning; they will be able independently to identify and take their next steps to help them make good progress.

A further consideration is the guidance and grade descriptors for inspecting schools in England under section 5 of the Education Act 2005. From September 2009 this includes evaluation of the use of assessment to support learning, through which inspectors should evaluate:

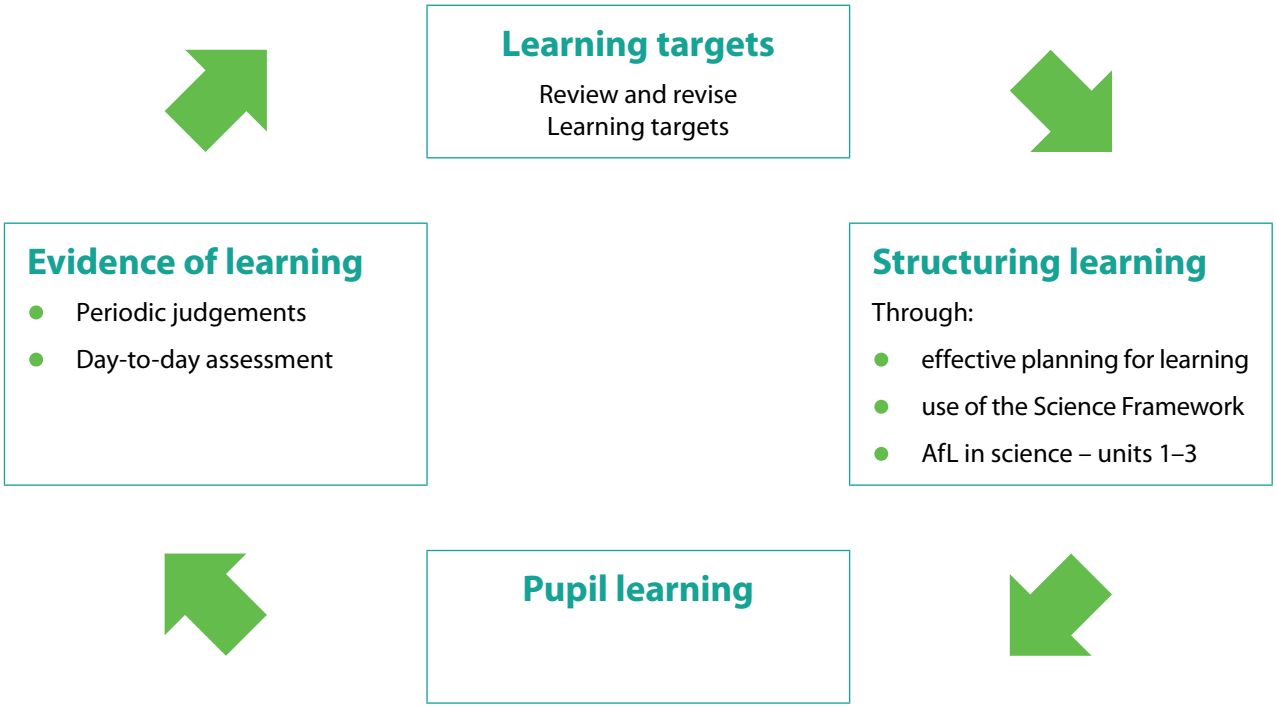
- how well teaching promotes learning, progress and enjoyment for all pupils
- how well assessment is used to meet the needs of all pupils.

The Ofsted evaluation criteria (2009) for a 'good lesson' are shown in the box below, with the ideas promoted in this unit highlighted.

> The teaching is consistently effective in ensuring that pupils are motivated and engaged. The great majority of teaching is securing good progress and learning. Teachers generally have strong subject knowledge which enthuses and challenges most pupils and contributes to their good progress. Good and imaginative use is made of resources, including new technology to enhance learning. Other adults' support is well focused and makes a significant contribution to the quality of learning. As a result of good assessment procedures, teachers and other adults plan well to meet the needs of all pupils. Pupils are provided with detailed feedback, both orally and through marking. They know how well they have done and can discuss what they need to do to sustain good progress. Teachers listen to, observe and question groups of pupils during lessons in order to reshape tasks and explanations to improve learning.
>
> From: Ofsted's evaluation schedule of judgements for schools inspected under section 5 of the Education Act 2005, updated September 2009.

Previous Assessment for Learning (AfL) documentation in science has focused on the setting of curricular targets for pupils, and had strong links to numerical targets. Pupil Learning targets constitute a slightly different approach, and can be used by teachers as part of an improvement cycle which places learning and the learner at the heart of assessment, and where assessment is integral to learning and teaching.

Improvement cycle



This resource provides support for teachers who are beginning to plan for the next steps in learning for pupils as a result of periodic judgements or day-to-day assessments in science. It provides clear Learning targets which show how to progress to the next level. These are supported by examples of science-specific contexts that link closely to the Assessing Pupils' Progress (APP) assessment criteria.

An example of the format of the Learning target tables is shown below. This example shows the Learning targets and contextual examples associated with *Assessment Focus 1: Thinking Scientifically, Thread 1: Using models for and in explanations*. It covers the Learning targets which will support pupils moving towards levels 6 and 7 in this area of science. Learning target tables for all Assessment Focuses can be found on pages 17–61.

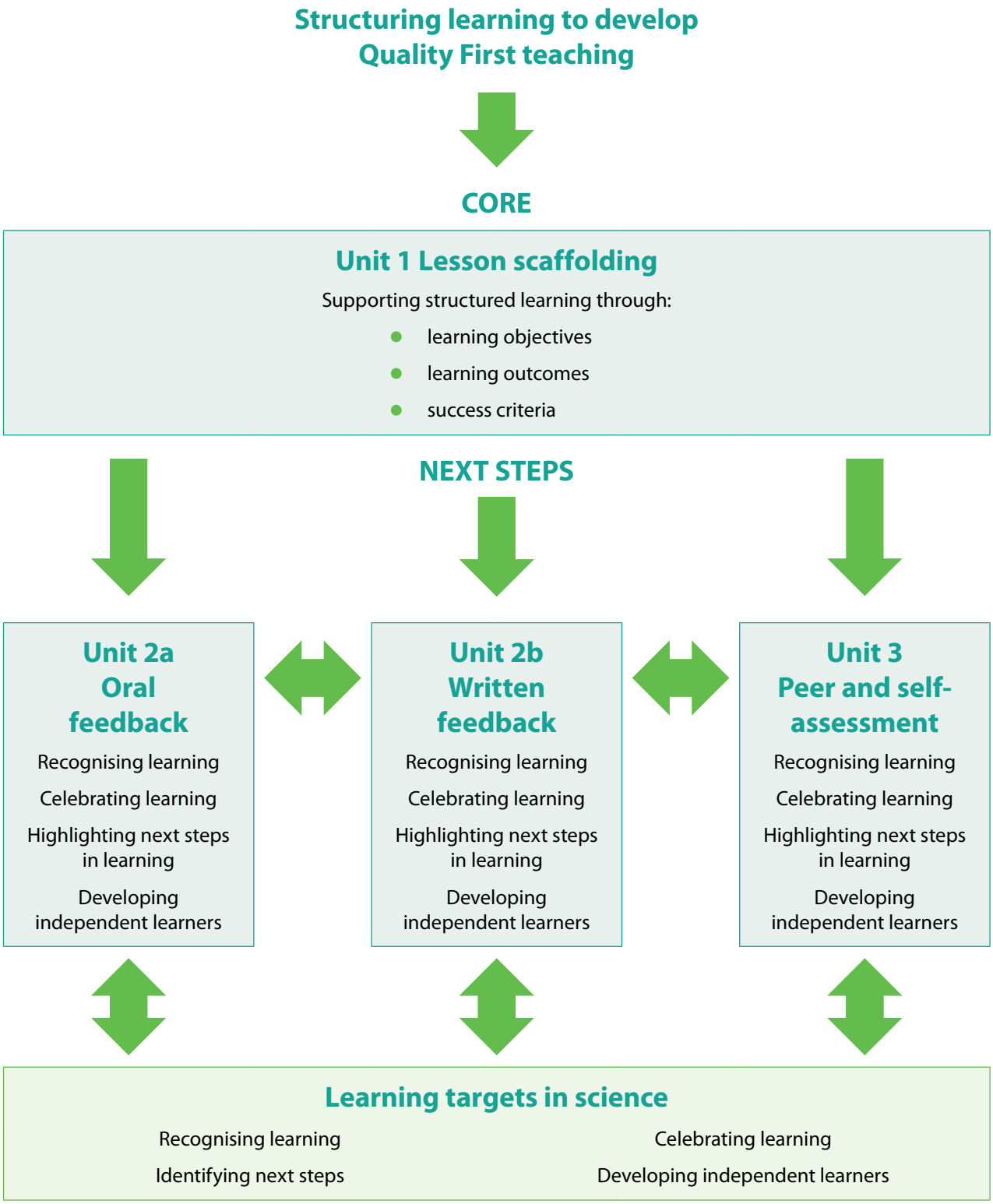
Level 7 APP assessment criteria	• Make explicit connections between abstract ideas and/or models in explaining processes or phenomena
Examples of some contexts to support lesson planning	• When explaining rock formation, link the ideas of particles, energy and forces • When explaining the effect of bleaching of corals, link the ideas of photosynthesis, symbiosis and interdependence
Level 7 Learning targets While learning about…pupils can:	• develop original models to explain ideas and events • justify the selection of a model to explain an idea • explain events explicitly linking different ideas or models

Level 6 APP assessment criteria	• Use abstract ideas or models or multiple factors when explaining processes or phenomena • Identify the strengths and weaknesses of particular models
Examples of some contexts to support lesson planning	• When explaining optical anomalies that depend on refraction of light, use an accepted analogy correctly, for example tank tracks or oars working at different speeds leading to change of direction, and provide reasons why this is a good model • When explaining the manufacture of soft centres in chocolates, use poppet beads to represent molecules being broken down into soluble molecules by enzymes • When explaining unfamiliar observations that show conduction and/or convection, use (for example) the energy transfer model • For any model used, pupils should be able to give strengths and weaknesses
Level 6 Learning targets While learning about…pupils can:	• explain logically ideas or events using abstract models in new situations • say what is good or bad about a model • select the most appropriate model to explain an idea
Level 5 APP assessment criteria	• Use abstract ideas or models or more than one step when describing processes or phenomena • Explain processes or phenomena, suggest solutions to problems or answer questions by drawing on abstract ideas or models

This unit is part of a series of support materials to strengthen AfL in science. It is a stand-alone unit. However, to secure effective AfL practice, a school or department may also need to consider the core unit Lesson scaffolding, and those on Oral feedback, Written feedback and Peer and self-assessment.

The diagram below shows how the units fit together, and they can be found on the National Strategies web area. Go to www.standards.dcsf.gov.uk/nationalstrategies and search using DCSF ref: 00932-2009.

How the science Assessment for Learning units fit together



1.1 Purpose of these materials

- To define what is meant by Learning targets.
- To explain the principles of setting Learning targets.
- To outline the process of setting Learning targets and how this can be linked explicitly to opportunities for periodic assessment through Assessing Pupils' Progress (APP).
- To identify strategies which enable pupils to take responsibility for their own progress and become more independent learners.

1.2 Key messages

- For Learning targets to support pupils' next steps in learning, AfL practice needs to be successfully established in the classroom.
- Learning targets are written in accessible language so that they can be easily shared and understood by pupils, parents and carers and other adults involved in the pupils' learning journey.
- When Learning targets are negotiated, teachers need to review and change their approaches so that the targets can be achieved.
- Pupils' Learning targets need to be reflected in teachers' planning: in learning objectives, learning outcomes and success criteria.

1.3 What's in it for the teacher?

Learning targets are tools that can help teachers to:

- support pupils in finding out what they need to do to make their next steps in learning so that they can make good progress in science
- fill the specific gaps and weaknesses in pupils' learning and understanding of science
- have personalised discussions with pupils and parents about achievements and next steps for learning
- be aware of the need for wave 2 or 3 intervention when quality first teaching has left some pupils behind
- help develop and refine teachers' understanding of progression in How Science Works (HSW)
- support the science department in meeting the numerical targets that have been set internally for the end of Key Stage 3.

Once gaps in pupils' learning have been identified, the National Strategies Framework can be used to support planning and also next teaching steps and learning opportunities.

1.4 What's in it for the pupils?

Learning targets help pupils to be in control of their own learning by being clear about what they can do in science, what their next steps are and how to achieve them. Learning targets can help develop their skills, knowledge and understanding of science and support good progress. The target focuses discussions with pupils and parents about achievements and allows teachers to be precise about the next steps in learning. As a result, pupils are more likely to experience personalised high quality first teaching, including guided learning and other intervention, to meet their needs.

The main principle underpinning the use of AfL is the development of the independent learner who is better prepared to take the next steps in learning with the appropriate support from their teacher and peers.

The independent learner

> 'Independent learners…are able to engage in self-reflection and to identify the next steps in their learning. Teachers should equip learners with the desire and the capacity to take charge of their learning through developing the skills of self-assessment.'
>
> ***Assessment for Learning: 10 principles, Assessment Reform Group, 2002***

1.5 AfL quality standards

These materials link closely with specific quality standards developed for AfL.

Day-to-day assessment

- **2.1** All teachers have a secure and shared understanding of AfL and how it impacts on learning and standards.
- **2.2** All teachers have a good understanding of progression in the key concepts and skills in their subject.
- **2.3** All teachers give pupils clear feedback that identifies next steps, and provide opportunities in lessons for pupils to discuss and act upon the feedback.
- **2.6** All pupils have the confidence, disposition and skills to evaluate the quality of their work and level of understanding, and to work with their teachers and peers to take the next steps in their learning.

Periodic assessment

- **3.3** APP is integral to tracking and target setting that ensures that all underachieving groups and individuals are receiving appropriate additional support.
- **3.4** APP criteria are shared and discussed regularly with every pupil to agree targets and review progress towards them.
- **3.5** Teachers use APP assessment information to inform whole-class learning and teaching, group intervention and one-to-one support and tuition.
- **3.6** Information from APP assessments is used to support transition and transfer.
- **3.7** Individual pupils' progress and curricular (Learning) targets (related to National Curriculum (NC) levels and informed by APP criteria) are regularly shared and discussed with parents and carers.

A self-evaluation tool used to develop the AfL quality standards and their link to APP can be found on the National Strategies web area. Go to **www.standards.dcsf.gov.uk/nationalstrategies** and search using DCSF ref: 00734-2009PDF-EN-03.

2. Learning targets

2.1 What is a Learning target?

A Learning target summarises the next step in expected pupil learning that has been identified through any assessment or review process. These should be used to inform teachers' on-going planning.

Learning targets are related and aligned to pupils' particular needs and written in language that is understood by, shared with and owned by the pupil. Learning targets could be agreed for long-term (e.g. a term, after a periodic judgement or year), medium-term (e.g. few weeks), or short-term (e.g. few lessons) periods of time.

They are:

- monitored as part of an overall profile of the pupil across all subjects
- shared with other staff to inform their plans
- explicit in short-term planning
- SMART (**S**pecific **M**easurable **A**chievable **R**elevant **T**ime-related).

2.2 Using Learning targets

As a result of regular dialogue with their teacher, pupils will know their Learning targets. They can also be communicated to parents through planners, virtual learning environments (VLEs), parents' meetings and other methods of communication. The Learning targets are also held in the teacher's own records and are passed on to other colleagues as necessary. This transfer of information is most likely to take place annually but can be required more frequently, especially if a science group is taught by more than one teacher.

Learning targets, as well as being helpful for individual pupils, can also be used to support next steps in learning for groups of pupils, classes, year groups or a Key Stage. The following shows examples of how Learning targets could be used in science.

Transitional

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Learning target for a Key Stage

The HSW skills of all pupils are improved

Learning target Year 7

Pupils can use a variety of investigative approaches in their own investigations

Periodic

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Learning target (medium-term plan)

In an investigation, pupils are able to take into account the key variables that they can and cannot control and include ways of minimising their effects

Gap found in AF4. Used to inform targets

Day-to-day

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Individual or group Learning target

'In our next investigation we will identify which variables can be changed and which cannot'

Day-to-day assessment is used to inform teacher–pupil and pupil–pupil dialogue

Personal pupil Learning target
'To improve I need to be able to:

plan the next investigation and tell my teacher

which variable I will change

which variables I will keep the same

which variable I will measure.'

Review pupils' progress to identify learning gaps and negotiate their Learning targets

Field of sunflowers by Christophe Libert © SXC 2010
Sunflowers by Anders Rosenlund © SXC 2010
Sunflower seeds by Jason Anthony © SXC 2010

2.3 Involving pupils

The aim of target setting is to make an impact on pupils' learning and achievement, so it is more effective if pupils participate in deciding their Learning targets. This will lead to greater ownership of the targets, independence in learning and increased confidence. Wherever possible, pupils should be encouraged to monitor their own progress towards their targets with support from teachers and assistants and, as they mature, to take more responsibility for this process.

Discussions about Learning targets, and what pupils might need to do as a next step, will help the pupils to recognise when teaching is addressing their needs. Pupils will know that they are being listened to and that their views are valued.

Pupils need to:	Adults need to:
Understand the importance of feedback and target setting in making progress in science	Give information and guidance to make choices
Have the opportunity to articulate their feelings as learners	Provide a supportive, safe environment and also challenge
Participate in discussion	Listen actively to pupils, and maximise opportunities for discussion
Indicate their views	Incorporate these views into planned actions

(A useful resource is *Maximising progress: Ensuring the attainment of pupils with SEN – Part 2: Approaches to learning and teaching in the mainstream classroom*, which can be found on the National Strategies web area. Go to **www.standards.dcsf.gov.uk/nationalstrategies** and search using Ensuring the attainment of pupils with SEN).

3. Success criteria

3.1 What are success criteria?

By using success criteria, pupils can develop their understanding of what they need to do or show to achieve the learning outcomes. In this context success criteria are the statements that help pupils recognise whether they have been successful in reaching their Learning targets. These can be set each lesson, or over a longer time period, allowing pupils to see what 'good' looks like.

Success criteria spell out the steps required to achieve the learning outcome and offer explicit guidance on how to be successful.

Success criteria are:

- linked to the learning outcome
- specific to an activity
- discussed and agreed with the pupils prior to beginning the learning activity
- scaffolded to focus pupils while they are engaged in the activity
- used as the basis for feedback and for peer and self-assessment.

For more information on structuring learning, refer to Unit 1: *Lesson scaffolding: Structuring learning to develop Quality First teaching in science*, which can be found on the National Strategies web area. Go to **www.standards.dcsf.gov.uk/nationalstrategies** and search using DCSF ref: 00932-2009PDF-EN-01.

3.2 Why use success criteria?

Success criteria help pupils understand what they are trying to learn and why, together with what is expected of them. They are vital in helping pupils to understand how they have been successful in any task or activity and hence are essential in the AfL and APP process.

Pupils who have experience of negotiating and working to success criteria are more able to use them to assess their own achievements and identify areas for improvement without relying upon others for guidance. Thus they develop an independent approach to learning – a vital learning and life skill.

3.3 How to set success criteria

Pupils can be helped in developing their own success criteria by:

- modelling the process for them
- allowing time to discuss the criteria
- letting the pupils work in groups to practise creating and using the criteria
- putting the criteria into pupil-friendly language.

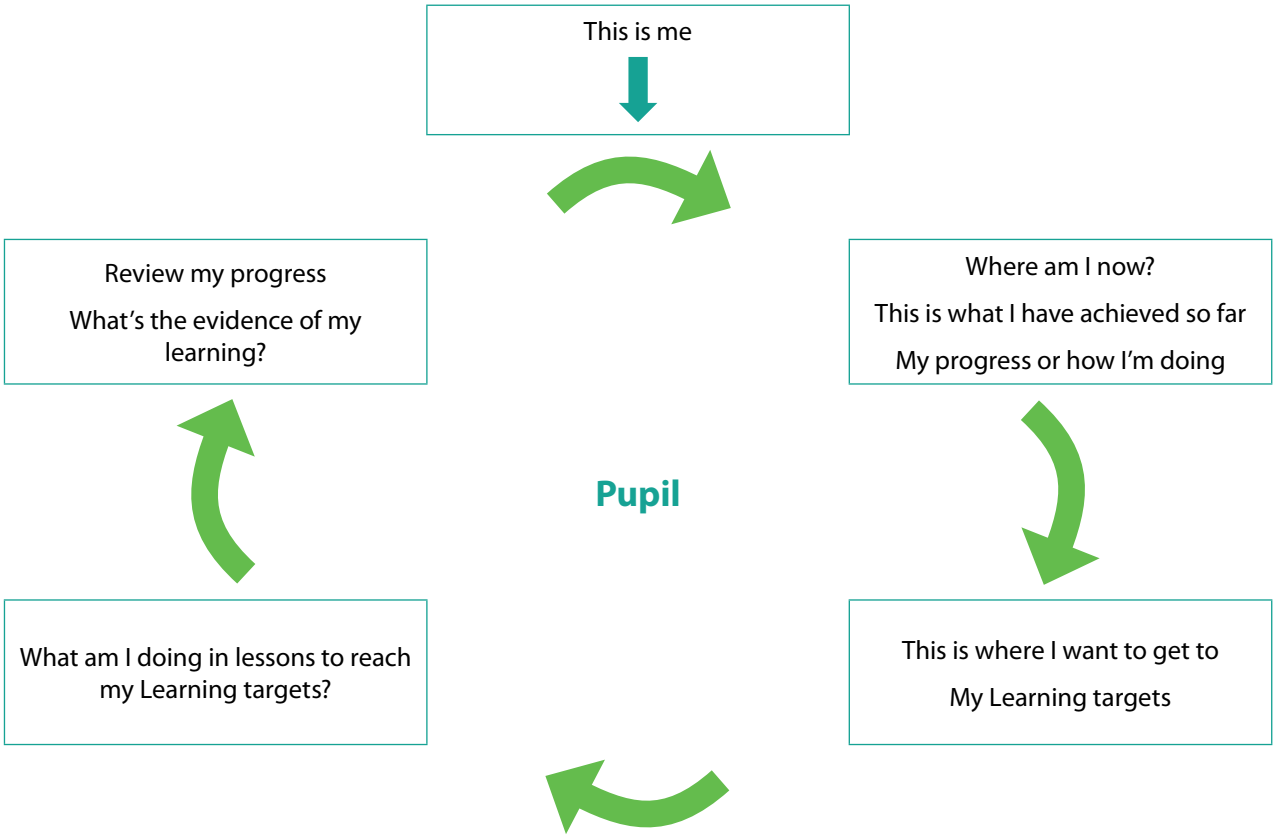
00061-2010BKT-EN

4. Using the resources

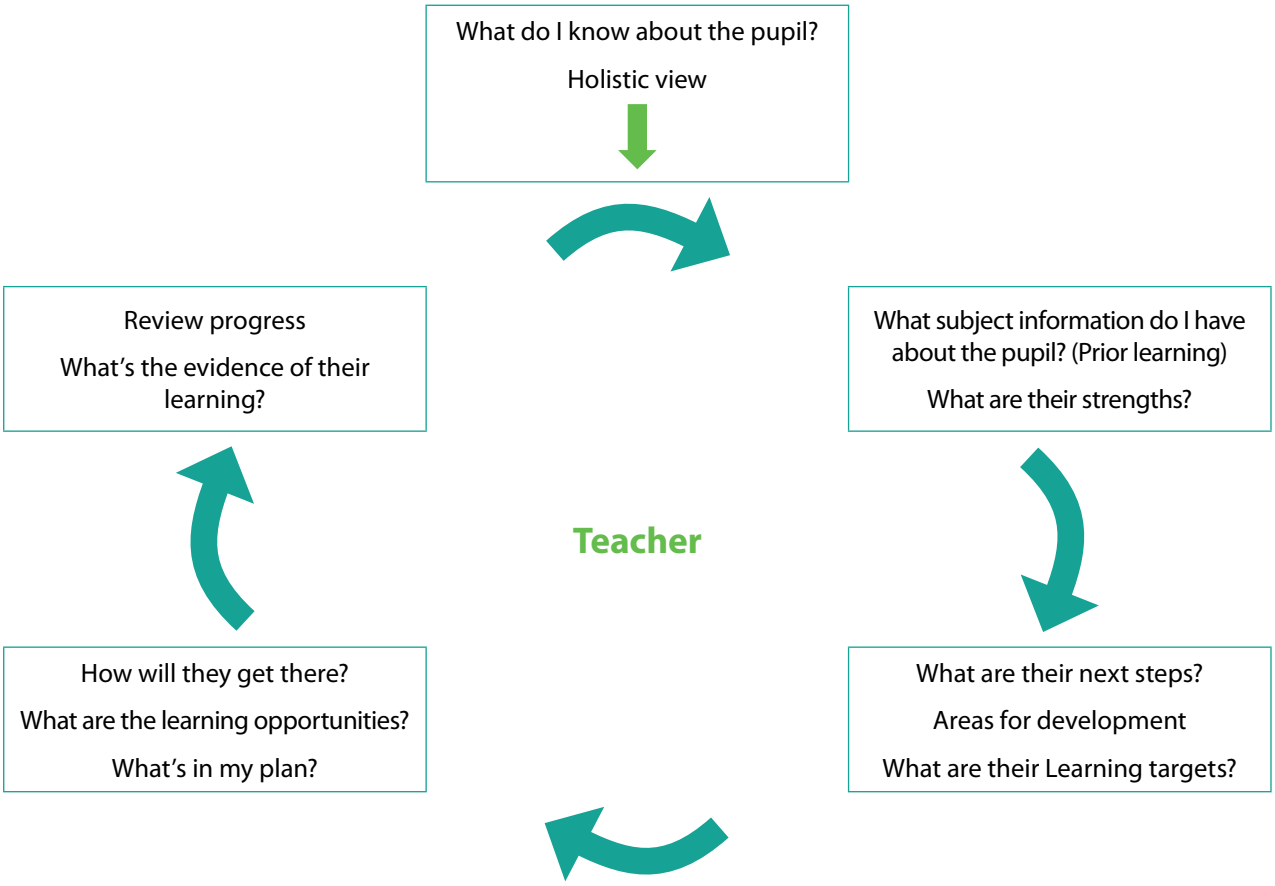
4.1 Models of learning

The following diagrams are two simple models of learning from two different perspectives: the *pupil's* and the *teacher's*. The effective use of Learning targets depends on understanding the thinking and learning that is going on at each stage.

Model of learning: Pupil



Model of learning: Teacher



4.2 How to use the supporting resources

The tables in this resource can be used to unpick the assessment criteria in the Assessment Guidelines for APP so as to provide pupils with Learning targets. These can be used at whatever layer is identified as appropriate. They could be used flexibly to:

- develop Learning Ladders for a particular context
- inform longer-term periodic targets for improvement
- develop success criteria to help pupils understand what 'good' looks like.

4.3 Using Learning target Level Ladders

Before constructing a **Learning target Level Ladder**, a teacher would need to:

- identify gaps in learning, through periodic or day-to-day assessment
- know what range of levels the class is working at
- check the appropriate Learning targets
- use the appropriate form and copy and paste the Learning targets from the relevant table into the column
- use the Learning Ladder to consider whether the scheme of learning can be adjusted to allow pupils the opportunity to address the gaps in their learning
- plan lessons that fit the context.

Examples of Learning Ladders

A template to use for constructing bespoke Learning target Level Ladders can be found within the resource file that accompanies this resource.

1. The first example shows a Learning Ladder within the context of investigating energy transfer by sound in different mediums; it concentrates on Assessment Focus 5, and covers levels 4–6.

Learning target Level Ladder

Context: Investigating energy transfer by sound in different mediums Assessment Focus 5		
Level	**Learning target**	**What's my evidence?**
6	• I can explain why results might be different from my prediction • I can explain any anomalous results using scientific knowledge and understanding • I can comment on how reliable the range of data is, taking into consideration repeat readings, equipment and procedure	
5	• I can recognise data that does not fit a pattern or trend • I can identify anomalies and explain why they do not fit the pattern	
4	• I can compare two or more sets of data to look for differences • I can state the evidence used in making my conclusion	

My next steps are:	Teacher's feedback:
What	What you did well:
How	How you did it well:
When	What you need to do next:

00061-2010BKT-EN

2. The second example shows a Learning Ladder within the context of explaining energy transfer in unfamiliar contexts, for example double glazing/vacuum flask, using the concept of heat energy transfer; it concentrates on Assessment Focus 1 and covers levels 4–6.

Context: Explaining energy transfer in unfamiliar contexts, for example double glazing/vacuum flask, using the concept of heat energy transfer Assessment Focus 1		
Level	**Learning target**	**What's my evidence?**
6	• I can say what is good or bad about a model • I can explain how ideas change as people working in science discuss new evidence	
5	• I can develop a description that uses abstract ideas or models of more than one step • I can suggest solutions to problems using scientific ideas	
4	• I can describe scientific ideas using a physical model • I can use scientific facts when describing processes	

My next steps are:	Teacher's feedback:
What	What you did well:
How	How you did it well:
When	What you need to do next:

00061-2010BKT-EN

4.4 Learning mats

Learning mats enable a teacher to display a number of Learning targets for either a pupil or a group of pupils. Printing them as a mat allows pupils to be regularly reminded of what their targets are.

Select the Learning targets at the appropriate level and within the appropriate Assessment Focus to compile a bespoke mat for pupils.

Examples of learning mat templates and completed learning mats can be found in Appendix 2 of this document and in the resources that accompany this document.

4.5 Top tips

- Start each Learning target with:
  - I can…
  - My next step is…
  - I need to be able to…
- Learning targets can be generic; you can add words specific to the context if this helps pupils to be clearer about what they have to do to be successful.
- Be prepared to break down the Learning targets further to provide specific success criteria for a lesson.
- Be alert to pupils' discussions where you can hear them showing they have reached their Learning target.
- Plan time to review where pupils are and to talk to pupils within a lesson so that you can negotiate Learning targets.
- Enjoy the realisation that pupils are managing their own learning, and experiencing success in science.

5. Learning targets linked to APP criteria

Learning targets can be developed in two ways, based on the APP criteria:

1. Learning targets can be based on the Assessment Focuses. In the examples below, the Learning targets are organised into five tables using the five APP Assessment Focuses. Each Assessment Focus has four threads to allow teachers to track progression in this particular area of science. The examples indicate how the Learning targets support pupils so that they are able to move to the next level of learning in science. Sections 5.1–5.5 on pages 17–61 give the five tables for Learning targets within each Assessment Focus.
2. Learning targets can be based on each attainment level as shown in sections 6.1–6.7 on pages 62–86.

5.1 Assessment Focus 1: Thinking scientifically

AF1 Thread	Using models for and in explanations	Weighing up evidence to construct arguments and explanations	The process of developing ideas including the role of the scientific community	Provisional nature of scientific evidence
Level 8 APP assessment criteria	• Describe or explain processes or phenomena, logically and in detail, making use of abstract ideas and models from different areas of science	• Select and justify an appropriate approach to evaluating the relative importance of a number of different factors in explanations or arguments	• Analyse the development of scientific theories through the emergence of new, accepted ideas and evidence	
Examples of some contexts to support lesson planning	• When explaining induced magnetism, link domain and particle models following independent research • When explaining molecular movement across cell membranes, link ideas about cell membrane structure and particle models, and ideas about energy transfer	• When deciding whether an organ transplant should be given to a smoker, justify the approach that weighs up all the available evidence that would influence the decision • When deciding whether to give a child the triple or individual MMR vaccines, pupils can take a critical stance that takes into account the limitations of the scientific evidence and also the emotive opinions that surround this decision	• When comparing different models of the atom, pupils explore how a particular model was developed in the light of new information • When investigating human evolution, pupils explore how new discoveries and controversies have led to changes in scientific thinking	
Level 8 Learning targets While learning about…pupils can	• Explain events logically linking different ideas or models beyond the level expected in normal science lessons • Use language that is ambitious, clear and relevant to the context • Use criteria to evaluate the appropriateness of a model	• Demonstrate a clear, critical stance on scientific ideas using evidence • Describe the limitations of evidence and the effect of this on the credibility of an argument • Justify an approach to evaluating an explanation or argument	• Analyse how a new theory came about over time by investigating the available evidence • Explain why scientific ideas are provisional • Recognise that different interpretations of evidence can lead to controversy	

00061-2010BKT-EN

Level 7 APP assessment criteria	• Make explicit connections between abstract ideas and/or models in explaining processes or phenomena	• Employ a systematic approach in deciding the relative importance of a number of scientific factors when explaining processes or phenomena	• Explain the processes by which ideas and evidence are accepted or rejected by the scientific community	• Explain how different pieces of evidence support accepted scientific ideas or contribute to questions that science cannot fully answer
Examples of some contexts to support lesson planning	• When explaining rock formation, link the ideas of particles, energy and forces • When explaining the effect of bleaching of corals, link the ideas of photosynthesis, symbiosis and interdependence	• When weighing up the reasons for the siting of a mobile phone mast/wind turbine, explain the scientific ideas that contribute to the argument • When solving a mystery as to why the dinosaurs died out, explain the various theories and why certain pieces of evidence are the most important in supporting particular theories	• When considering the use of sunbeds, use a values continuum to explore other people's viewpoints and question the validity of their evidence • When considering global warming as a phenomenon, question the use of evidence to support particular points of view	• When making suggestions for solving the world food problem, show how evidence for the use of genetically modified (GM) crops has generated questions that cannot yet be answered • When debating the evidence for global warming, generate a piece of discursive writing • When trying to explain the origins of the universe, use a variety of evidence from different sources, for example information from the Hubble telescope, to put forward an accepted idea
Level 7 Learning targets While learning about…pupils can	• Develop original models to explain ideas and events • Justify the selection of a model to explain an idea • Explain events explicitly linking different ideas or models	• Consider and weigh up all the evidence available • Explain how and why some pieces of evidence are more important than others when explaining scientific ideas or events	• Explain how scientists accept or reject each others' ideas and evidence using peer review • Question assumptions, prejudice and bias in scientific evidence	• Explain how evidence has supported accepted scientific ideas • Explain how evidence can enable further questions to be asked • Explain how emerging evidence is helping to explain scientific theories

Level 6 APP assessment criteria	• Use abstract ideas or models or multiple factors when explaining processes or phenomena • Identify the strengths and weaknesses of particular models	• Describe some scientific evidence that supports or refutes particular ideas or arguments, including those in development	• Explain how new scientific evidence is discussed and interpreted by the scientific community and how this may lead to changes in scientific ideas	• Describe some scientific evidence that supports or refutes particular ideas or arguments, including those in development
Examples of some contexts to support lesson planning	• When explaining optical anomalies that depend on refraction of light, use an accepted analogy correctly, for example tank tracks or oars work at different speeds leading to change of direction. Provide reasons why this is a good model • When explaining the manufacture of soft centres in chocolates, use poppet beads to represent molecules being broken down into soluble molecules by enzymes • When explaining unfamiliar observations that show conduction and or convection, use for example the energy transfer model • For any model used pupils can give strengths and weaknesses	• When comparing ideas about rotation of the Earth around the sun, identify evidence and present this in a different form, showing how this supports or refutes the different ideas • When discussing the emergence of ideas about matter, describe the changes in ideas that have happened over time • Using research into the ideas about how blood circulates, describe the changes in ideas that have happened over time	• When debating about whether fashion shoes should be banned, provide evidence presented from different points of view, some of which may be influenced by a particular interest, for example shoe manufacturers, teenage girls or the medical profession • When working on a forensic problem, recognise where ideas have changed when new evidence is presented and discussed by the forensics team	• When comparing ideas about rotation of the Earth around the sun, identify evidence and present this in a different form, showing how this supports or refutes the different ideas • When discussing the emergence of ideas about matter, describe the changes in ideas that have happened over time • Using research into the ideas about how blood circulates, describe the changes in ideas that have happened over time
Level 6 Learning targets While learning about…pupils can	• Explain logically ideas or events using abstract models in new situations • Say what is good or bad about a model • Select the most appropriate model to explain an idea	• Describe evidence which supports or disproves accepted or developing scientific ideas	• Explain how ideas change as people working in science discuss new evidence • Explain how ideas change as a result of interpreting evidence in different ways	• Describe evidence which supports or disproves accepted or developing scientific ideas

00061-2010BKT-EN

Level 5 APP assessment criteria	• Use abstract ideas or models of more than one step when describing processes or phenomena • Explain processes or phenomena, suggest solutions to problems or answer questions by drawing on abstract ideas or models	• Identify the use of evidence and creative thinking by scientists in the development of scientific ideas	• Recognise scientific questions that do not yet have definitive answers
Examples of some contexts to support lesson planning	• When explaining how an electric circuit works, pupils use an accepted model, for example water flow • When explaining the diffusion of perfume in a room, pupils use an analogy, for example a crowd leaving a football match, or the particle model	• When considering potential solutions to a problem, pupils recognise that alternative ideas exist; they test these ideas in order to consider the evidence and come up with innovative solutions, for example designing a straw bridge to withstand the forces experienced during flooding • Using research into inventors, for example, Archimedes, Dyson, Trevor Baylis, identify the ingenious ideas and how these enabled progress towards a solution. Discuss the scientific theories underpinning these ideas • When outlining the theory of evolution, use fossil evidence and the model of natural selection to show how ideas progressed	• When considering the mystery of possible life on Mars or other planets, pupils realise that we cannot confidently answer this question yet
Level 5 Learning targets While learning about…pupils can	• Explain ideas or events using abstract models in familiar situations • Develop a description that uses abstract ideas or models of more than one step • Suggest solutions to problems using scientific ideas	• Show how scientists develop ideas by looking at a problem in different and imaginative ways and how this can be linked to the use of evidence or vice versa	• Give examples of instances where science cannot answer all our questions

00061-2010BKT-EN

Level 4 APP assessment criteria	• Use simple models to describe scientific ideas	• Identify scientific evidence that is being used to support or refute ideas or arguments	• Use scientific ideas when describing simple processes or phenomena	• Identify scientific evidence that is being used to support or refute ideas or arguments
Examples of some contexts to support lesson planning	• Use a model of the solar system and say how this is used to show distance between planets • When describing absorption of food from the gut, pupils can use tights to represent the gut wall	• When researching, pupils can sort evidence into for or against, for example: – drinking red wine in moderation – use of antibacterial hand wash/household products – the siting of wind turbines	• Describe the mechanical and chemical process of digestion as food passes through the gut • Describe, using scientific words, what happens to an ice cube left on the window sill • Describe, using scientific words, what happens to lamps in an electrical circuit	• When researching, sort evidence into for or against, for example: – drinking red wine in moderation – use of antibacterial hand wash/household products – the siting of wind turbines
Level 4 Learning targets While learning about…pupils can	• Describe scientific ideas using scientific terms correctly • Describe scientific ideas using a physical model	• Recognise when scientific evidence is for or against an argument • Recognise when scientific evidence supports an idea or not	• Use scientific language to describe processes and observations • Use scientific facts when describing processes and observations	• Recognise when scientific evidence is for or against an argument • Recognise when scientific evidence supports an idea or not

00061-2010BKT-EN

Level 3 APP assessment criteria	• Represent things in the real world using simple physical models	• Identify differences, similarities or changes related to simple scientific ideas, processes or phenomena • Use straightforward scientific evidence to answer questions, or to support their findings	• Respond to ideas given to them to answer questions or suggest solutions to problems	
Examples of some contexts to support lesson planning	• When representing the solar system, make papier mâché models of the planets • When representing the structure of a volcano, make a 3D model • Model the freezing and thawing of rocks using water frozen in a bottle	• When observing, sort and classify organisms/materials • Sequence events, for example: – identify changes during and after filtering – growth/movement of an object on different surfaces • Use evidence or support findings from simple observations/measurements to answer questions, for example: – 'How do you think changing the type of surface/temperature/amount of light will affect…?'	• Answer questions like: – Why do you think there are fewer daisies near the wall? – Why do you think the shoe moves less well on the surface? – Where do you think the water in the puddle has gone? – How can we keep our drink hotter for longer?	
Level 3 Learning targets While learning about…pupils can	• Make a model to represent something that they have seen	• Identify differences, similarities or changes within things to do with science • Use scientific evidence and ideas to answer questions	• Answer questions/solve problems • Support what they have found out using their own experience	

00061-2010BKT-EN

Level 2 APP assessment criteria		• Make comparisons between basic features or components of objects, living things or events • Sort and group objects, living things or events on the basis of what they have observed	• Draw on their observations and ideas to offer answers to questions • Respond to suggestions to identify some evidence (in the form of information, observations or measurements) needed to answer a question	
Examples of some contexts to support lesson planning		• Locate and collect relevant information, for example, make observations of plants and animals, and group them according to features • When using an 'Odd one out' strategy, give three words and when asked to identify the odd one out give reason(s) for their choice; for example, water, sand and ice	• When investigating filtration to separate sand from salt water, identify that the sand has separated and this process can be used to separate a different solid from a liquid • When 'solving a crime', pupils can select the evidence provided that could be used to catch the criminal	
Level 2 Learning targets While learning about…pupils can		• Compare features or components of objects, living things or events • Use observations to group objects, living things or events	• Use what they see and their own ideas to offer answers to questions • Use help to identify evidence needed to answer a question	

00061-2010BKT-EN

Level 1 APP assessment criteria		• Recognise basic features of objects, living things or events	• Ask questions stimulated by their exploration of their world • Draw on their everyday experience to help answer questions • Respond to suggestions to identify some evidence (in the form of information, observations or measurements) that has been used to answer a question	

5.2 Assessment Focus 2: Understanding the applications and implications of science

AF2 Thread	Effect of societal norms (political, social, cultural, economic) on science	Creative use of scientific ideas to bring about technological developments	Implications, benefits and drawbacks of scientific and technological development of society and the environment	How science relates to jobs and roles
Level 8 APP assessment criteria	• Describe ways in which the values of a society influence the nature of the science developed in that society or period of history	• Explain the unintended consequences that may arise from scientific and technological developments	• Make balanced judgements about particular scientific or technological developments by evaluating the economic ethical/moral, social or cultural implications • Evaluate the effects of scientific or technological developments on society as a whole	
Examples of some contexts to support lesson planning	• When discussing the role of science in solving problems, consider and evaluate a range of issues that can arise as a result; for example, stem cell research, human embryology and fertilisation issues • When researching the discovery of Mendel's laws of inheritance and the implications for society at the time, consider the interplay between scientific theory and evidence	• When considering benefits, explain the unintended consequences and their impact; for example: – use of antibiotics in animal feeds and the over-prescription of antibiotics, leading to antibiotic-tolerant bacteria and superbugs – use of DDT in malaria eradication, and bio-accumulation in the food web	• When exploring how the World Wide Web has supported the development of a global community, evaluate the impact of economic, communication and scientific development • When debating, include arguments for the economic ethical/moral, social or cultural implications of scientific and technological development of society and the environment to inform balanced argument; for example:	

00061-2010BKT-EN

	• When researching – G8 summit and factors contributing to global warming – industrial development of materials from recycled plastics tyres – socioeconomic limitations of recycling plants describe how media and pressure groups influence attitudes in society and political decisions	• when researching the 'spin-off ' from Space technology used in food, medical and engineering contexts, for example: – Dacron for repairing septal defects in hearts – dehydrated convenience food – cadmium battery disposal – toxic waste – accidental discovery of penicillin identify and explain any unintended consequences of the developments	– embryo selection for sibling donor therapy (refer to Jodie Picoult: *My Sister's Keeper*) – xenotransplantation (refer to Malorie Blackman: *Pig Heart Boy*) – use of dispersants on oil spillages – building the Severn barrage	
Level 8 Learning targets While learning about…pupils can	• Describe how the values of society influence scientific or technological developments • Describe how society has caused changes in scientific or technological developments • Describe how science has changed through history	• Identify and explain how scientific and technological developments have been used in ways that were not intended	• Evaluate how and why scientific or technological developments have had an economic impact on society • Evaluate how and why scientific or technological developments have influenced different cultures • Evaluate how and why scientific or technological developments can have ethical or moral consequences • Evaluate how and why scientific and technological developments have influenced society • Evaluate the ethical and moral issues faced by people who use science or technology in their jobs	

Level 7 APP assessment criteria	• Suggest economic, ethical/ moral, social or cultural arguments for and against scientific or technological developments • Suggest ways in which scientific and technological developments may be influenced	• Explain how creative thinking in science and technology generates ideas for future research and development	• Explain how scientific discoveries can change world views	

Examples of some contexts to support lesson planning	• When discussing or debating, consider economic, ethical, political, cultural and social issues, for example growing new body parts through stem-cell technology/ designer babies
	• When evaluating, consider the strength of the link between evidence and conclusions; for example:
	– factors that affect the growth of the human embryo and foetus (smoking, diets, drugs)
	– siting of new housing/ leisure development/ chemical plant/quarry on green belt
	– development of cars to reduce emissions
		• When researching, make links between the idea and follow-up development, for example:
		– Mendeleev and his production of the Periodic Table through to the models of the structure of the atom and how this has led to further developments in understanding of atomic structure, for example using X-ray crystallography
		– Contemporary examples of new inventions:
		  – wind-up radio/torch
		  – developing countries – provision of solar cells to transfer energy to simple devices
		– Recent contemporary inventions:
		  – hand dryer that blows not heats
		  – bagless vacuum cleaner
		  – bladeless desk fan
			• When evaluating changes in accepted views consider the strength of the link between evidence and conclusions; for example:
			– climate change and global warming
			– heavy metals from effluent accumulating in the food chain; for example, mysterious deaths in Minimata, Japan, 1949–1956
			– how the knowledge and understanding of the HIV virus and its transmission changed attitudes and behaviours	

Level 7 Learning targets While learning about…pupils can	• Use economic, social or cultural arguments to justify scientific or technological developments • Argue how ethical and moral issues have influenced science and technological development • Evaluate how science and technology have impacted on different cultures • Argue how economics have influenced scientific and technological development • Suggest ways in which scientific and technological developments may be influenced by economic, cultural and societal factors	• Explain how creative thinking has developed science and technology • Explain how creative thinking generates ideas for future research	• Explain how science has changed the world around us	

Level 6 APP assessment criteria	• Describe how different decisions on the uses of scientific and technological developments may be made in different economic, social or cultural contexts	• Describe how particular scientific or technological developments have provided evidence to help scientists pose and answer further questions	• Explain how societies are affected by particular scientific applications or ideas	• Describe how aspects of science are applied in particular jobs or roles
Examples of some contexts to support lesson planning	• When researching different developments, describe why different decisions are made, for example: – why countries make different decisions about, say, production of GM tomatoes or building nuclear power stations – how different cultures influence decisions on the use of the science and technology of fertility/ early detection of foetal abnormalities – why different countries may reach different decisions on fossil fuel consumption in the light of scientific and technological developments	• When researching, describe evidence used to prompt further questions, for example: – how telescopes, electron microscopes, medical scanning and imaging have increased our knowledge and understanding and led to further questions; for example about the incidence of breast cancer within a family – how evidence from burning biofuels has led to questions about whether fossil fuels or biofuels have a greater impact on the environment – how evidence from early testing and diagnosis of foetal abnormalities has led to questions about next steps	• When analysing the effects on societies, explain underlying ideas or applications, for example: – why life expectancy has increased since the introduction of antibiotics/ immunisation/screening – how living in the flight path of a major city airport impacts on people's lives – how genetic fingerprinting has influenced crime and detection – how the development of technology, for example the internet, affects entertainment, communication, transport, commerce and education	• When placing learning within a relevant contemporary context, recognise how it is used; for example: – a police forensic scientist can interpret evidence from chromatograms – a baker uses optimum conditions for the proving of bread – a designer of theme park rides uses ideas of balanced forces – a sports technologist selects appropriate materials to enhance performance useful link **www.scienceandmaths.net**
Level 6 Learning targets While learning about…pupils can	• Describe how science and technology are used in different cultures • Describe how costs affect decisions on the uses of science and technology • Describe how science and technology affects societies	• Describe how evidence leads to further investigation • Describe how some science and technology developments have been used to ask and answer questions	• Explain how some science and technology has helped society	• Describe how people use science in their jobs • Describe how science is used in different jobs

00061-2010BKT-EN

Level 5 APP assessment criteria	• Identify ethical or moral issues linked to scientific or technological developments • Describe different viewpoints a range of people may have about scientific or technological developments		• Link applications of science or technology to their underpinning scientific ideas • Indicate how scientific or technological developments may affect different groups of people in different ways	
Examples of some contexts to support lesson planning	• When researching, suggest why: – an athlete may/may not consider taking performance-enhancing drugs – the use of chemicals to stimulate growth in plants may be promoted/ prevented – the use of crop plants genetically engineered to make them resistant to weedkillers may be promoted/ prevented – research breeding programmes may be advocated/barred when considering species facing extinction • Describe the different views people have about wind farms		• When researching new applications of science or technology, explore links to scientific concepts, for example energy transfer in a: – refrigerator – oven – vacuum flask – greenhouse • When considering the effects on different groups of people, describe, for example: – the impact of vaccination/ immunisation programmes, such as smallpox/BCG/MMR – the impact of acid rain on buildings	
Level 5 Learning targets While learning about …pupils can	• Consider whether it is right or wrong to use different types of technology and science • Describe the views people have about using science and technology		• Describe how science and technology affect people • Describe how scientific ideas have been developed and used	

Level 4 APP assessment criteria			• Recognise applications of specific scientific ideas • Describe some simple positive and negative consequences of scientific and technological developments	• Identify aspects of science used within particular jobs or roles
Examples of some contexts to support lesson planning			• When considering new ideas, explore the positives and negatives; for example of: – low-energy light bulbs – increased availability of non-seasonal fruits and vegetables – recycling rubbish – household chemicals • Explore how sports shoes help players to not slip in games like basketball	• When considering how science is used in jobs, make links, for example: – hairdressers use bleach to change hair colour, chemicals to neutralise perms and heat to straighten or dry hair – swimming pool attendants use chemicals to kill microbes – dieticians use their knowledge of nutrition to provide a balanced diet for different patients
Level 4 Learning targets While learning about …pupils can			• Identify the good and bad uses of technology and science • Identify how science is used in different ways in everyday life	• Identify aspects of science in specific jobs • Identify how different jobs use science

Level 3 APP assessment criteria			• Link applications to specific characteristics or properties • Explain the purposes of a variety of scientific or technological developments	• Identify aspects of our lives, or of the work that people do, which are based on scientific ideas
Examples Eof some contexts to support lesson planning			• When considering a new development in science and technology, suggest why it is an improvement; for example: – describe how and why a mobile phone is used – describe how mobile phones have changed over time • Explain why materials are chosen for a purpose, for example: – waterproof – elastic – lightweight • Explain why a refrigerator is used to store food	• When placing learning within a relevant contemporary context, recognise why: – a hairdresser uses chemicals to colour and treat hair – swimming pool attendants use chemicals to kill germs – school cooks use their knowledge of nutrition to provide healthy meals
Level 3 Learning targets While learning about…pupils can			• Say how and why some science or technology is used • Say how and why some science or technology has changed	• Say how science is used in their life or in some jobs

Level 2 APP assessment criteria			• Identify scientific or technological phenomena and say whether or not they are helpful • Describe, in familiar contexts, how science helps people do things • Express personal feelings or opinions about scientific or technological phenomena	• Identify people who use science to help others
Examples of some contexts to support lesson planning			• When researching, describe differences in dietary needs of different people • When visiting/observing, say how they feel about a sewage plant/power station/wind farm/I-phone/ultrasound image/X-ray/growing plant • When considering everyday items such as a dental brace/vacuum flask/electrical devices that make household tasks easier, describe what each does • When researching, describe how antibacterial handwash can prevent spread of infections in hospitals	• When considering how science might help others: – explain why wearing ear defenders helps people who work in loud environments – suggest how these people use science to help others: – dentist – nurse – vet – farmer – hairdresser – construction worker – cook
Level 2 Learning targets Whilst learning about…pupils can			• Identify scientific or technological phenomena and say whether or not they are helpful • Describe, in familiar contexts, how science helps people do things • Express personal feelings or opinions about scientific or technological phenomena	• Identify people who use science to help others

Level 1 APP assessment criteria			• Recognise scientific and technological developments that help us • Identify a link to science in familiar objects or contexts	

5.3 Assessment Focus 3: Communicating and collaborating in science

AF3 Thread	Using appropriate presentation skills to enhance communication of scientific findings and arguments	Explaining ideas and evidence using appropriate conventions, terminology and symbols	Presenting a range of views judging any possible misrepresentation	Scientists communicating worldwide using conventions
Level 8 APP assessment criteria	• Present robust and well-structured explanations, arguments or counter-arguments in a variety of ways		• Critically evaluate information and evidence from various sources, explaining limitations, misrepresentation or lack of balance	• Suggest the specialisms and skills that would be needed to solve particular scientific problems or to generate particular new scientific or technological developments
Examples of some contexts to support lesson planning	• When learning to present an argument for recycling, pupils first analyse the features of an effective argument in a different context and then apply these features in presenting their own argument • When presenting an explanation about how the eye works, pupils use a range of methods to make it clear to their audience (e.g. PowerPoint, graphics, spoken explanation, video, audio, demonstration) • When debating the need for public transport, pupils collect evidence for and against and use this successfully to support their arguments and refute opposing arguments		• When evaluating the merits of cloning animals, pupils take into account limitations in the available evidence when making a judgement about whether the process is beneficial • When presenting an argument about legal speed limits, pupils evaluate the strength of evidence presented by organisations like the 'Safety Camera Partnership' and motoring magazines in order to argue their case	• While considering the design of the athletics stadium for the Olympics, pupils suggest which science specialisms it might be useful to bring together • While considering the development of prosthetic limbs to enhance athletic performance, pupils suggest which science specialisms might be useful to the process

00061-2010BKT-EN

		• When developing their ideas about the importance of evidence-based arguments, pupils evaluate claims made by manufacturers of controversial products to arrive at a balanced view about whether there is a convincing scientific basis to support the product (e.g. dowsing rods or detox footbaths). They research using information from primary (collecting their own data) and secondary sources	
Level 8 Learning targets While learning about…pupils can	• Present well-structured explanations, arguments or counter-arguments in a variety of ways that stand up to challenge	• Evaluate information to identify limitations, misrepresentation and/or bias	• Suggest which scientific specialisms would be required to solve specific problems or generate new scientific developments

Level 7 APP assessment criteria	• Effectively represent abstract ideas using appropriate symbols, flow diagrams and different kinds of graphs in presenting explanations and arguments	• Explain how information or evidence from various sources may have been manipulated in order to influence interpretation	• Explain how scientists with different specialisms and skills have contributed to particular scientific or technological developments
Examples of some contexts to support lesson planning	• When investigating the outcomes of genetic combinations, pupils explain why inbreeding can lead to inherited disorders, using punnet squares to help • When explaining chemical reactions, pupils use particle models and symbol equations to represent clearly what is happening • When presenting an argument for using energy-saving light bulbs, pupils use energy-accounting systems, including Sankey diagrams, to explain their case	• When studying vaccination, pupils are guided to critique the evidence presented against MMR • In a context such as GM crops, climate change or road safety, pupils are supplied with a range of data or information and are asked to come up with two opposing positions by using and presenting the evidence selectively	• From a list of science specialists, pupils find out what they do and identify who might be useful in a team; for example, when crossing the Arctic on foot, or sailing the Atlantic • Pupils research the range of different specialists involved in developing a Formula One car • Pupils consider advantages and disadvantages of scientists with different specialisms working together, for example, an environmentalist, a meteorologist and an engineer collaborating on developing a wind farm
Level 7 Learning targets While learning about…pupils can	• Present explanations and arguments about abstract ideas using appropriate symbols, diagrams and graphs	• Explain how information and evidence may be manipulated to influence people	• Explain how scientists, who are experts in different areas, have worked together to contribute to an idea or development

00061-2010BKT-EN

Level 6 APP assessment criteria	• Choose forms to communicate qualitative or quantitative data appropriate to the data and the purpose of the communication	• Distinguish between data and information from primary sources, secondary sources and simulations, and present them in the most appropriate form	• Identify lack of balance in the presentation of information or evidence	
Examples of some contexts to support lesson planning	• When analysing data on the solar system, pupils choose appropriate ways to display the different data sets • When presenting information about air pollution, explain why they would choose different communication methods for different audiences; for example, children or adults • When analysing data on height distribution in the class, discuss how best to present the data and what are the advantages of histograms	• When investigating the effect of exercise on heart rate, compare results with secondary data and compare and contrast both findings clearly • When investigating the reaction between acid and metals, use experimental data, plus data from secondary sources, to construct a reactivity series. Comment on any contradictions between the two sources of evidence • When studying elasticity, use simulation software about bouncing balls as well as first-hand data to develop a conclusion about relationships between height of drop and height of bounce. Present findings clearly, distinguishing between the two sources of evidence	• When presenting an argument about a controversial topic, for example. probiotic yogurt drinks or anti-rust paint, highlight the claims made in the advertisements and identify whether they are backed up by evidence • When learning about bias in the presentation of science, compare articles about health risks of mobile phones/masts from different newspapers to identify examples of sensationalisation and discuss the reliability of the sources of evidence	
Level 6 Learning targets While learning about…pupils can	• Independently select the most useful ways to present qualitative and quantitative data • Explain which type of presentation is best for the data or the task	• Recognise the difference between a primary and a secondary source of evidence and information and know when the evidence comes from a simulation • Present the different kinds of evidence clearly	• Identify bias in information or evidence	

00061-2010BKT-EN

Level 5 APP assessment criteria	• Decide on the most appropriate formats to present sets of scientific data, such as using line graphs for continuous variables	• Use appropriate scientific and mathematical conventions and terminology to communicate abstract ideas	• Distinguish between opinion and scientific evidence in contexts related to science, and use evidence rather than opinion to support or challenge scientific arguments	• Suggest how collaborative approaches to specific experiments or investigations may improve the evidence collected
Examples of some contexts to support lesson planning	• When analysing changes in populations over time, decide to draw a line graph and say why the decision was made • When presenting data about cooling by evaporation decide to combine two sets of results (of the temperature drop of a thermometer wrapped with water-soaked cotton wool and one wrapped with alcohol-soaked cotton wool) into a single table • When analysing data on global warming, explain how changing the scale on a graph can distort the message	• When explaining their ideas about why plants in a rain forest grow quickly, use correct scientific words • When learning about elements and compounds, represent these using correct chemical symbols • When comparing the efficiency of different electrical appliances, use simple Sankey diagrams to show how the amount of energy dissipated varies	• When explaining the effects of smoking, sort statement cards into evidence and opinion • When examining claims made by manufacturers of anti-rust paints, decide which are based on scientific evidence • When examining the benefits of speed cameras, use only evidence to support arguments	• When investigating what happens when magnesium burns in air, record change of mass in a class table. Explain how the cumulative evidence for an increase of mass links to the theory of oxidation • When surveying plant populations in a field, accumulate evidence from individual quadrants to strengthen their conclusion • When investigating the distance moved by trolleys of different mass, repeated results are generated to ensure the average is more reliable
Level 5 Learning targets While learning about …pupils can	• Select the most useful ways of presenting information, given a range of choices, for example when a line graph should be used rather than a bar chart	• Use clear sentences, scientific words and symbols correctly when describing abstract ideas and observations	• Support or challenge scientific arguments using evidence, not opinion	• Describe how working together could improve an investigation, for example by making it more reliable

00061-2010BKT-EN

Level 4 APP assessment criteria	• Select appropriate ways of presenting scientific data	• Use appropriate scientific forms of language to communicate scientific ideas, processes or phenomena • Use scientific and mathematical conventions when communicating information or ideas		
Examples of some contexts to support lesson planning	• When learning how to present information, for example about diets, pollution or traffic accidents, a range of different graphs/tables/charts and diagrams are given and pupils then state how a particular presentation helps make the information clearer	• When making electric circuits, state the relationship between cells and bulb brightness using the correct scientific form of language • When modelling the water cycle, correctly order the process words involved • When recording measurements use correct units; for example, length (mm), force (N), temperature (°C)		
Level 4 Learning targets While learning about…pupils can	• Select useful ways of presenting information	• Use clear sentences, scientific words and symbols to describe simple ideas and observations		

Level 3 APP assessment criteria	• Present simple scientific data in more than one way, including via tables and bar charts	• Use scientific forms of language when communicating simple scientific ideas, processes or phenomena		• Identify simple advantages of working together on experiments or investigations
Examples of some contexts to support lesson planning	• When investigating habitats, use a bar chart to show the numbers of woodlice in different locations • When recording the pH of various solutions, record the colour and pH in a table • When recording the results from an investigation into the stretching of a spring, record the mass and length in a given table	• When learning about electricity, use scientific words, for example, cell, battery, lamp, light bulb, and simple comparative words, for example, brighter, dimmer, higher and lower, to describe what they see • When presenting data about themselves and others, use correct units; for example, height (cm) • When observing solubility, say what they see happening; for example, using words such as bubbles, dissolve, disappear, solid, liquid		• Give opportunities to work in groups and to discuss the benefits, for example: – when investigating fruit batteries, identify variables to change – when explaining circuits, form a clear explanation about how a torch works – when gathering data about change of state, discuss how to allocate different roles when heating ice
Level 3 Learning targets While learning about …pupils can	• Draw tables and bar charts	• Show what has been found out with some support • Use simple scientific words to describe or compare correctly • Include scientific terms and symbols (e.g. units)		• Say how working together has helped improve their learning

00061-2010BKT-EN

Level 2 APP assessment criteria	• Present their ideas and evidence in appropriate ways	• Use simple scientific vocabulary to describe their ideas and observations	• Respond to prompts by using simple texts and electronic media to find information	• Work together on an experiment or investigation and recognise contributions made by others
Examples of some contexts to support lesson planning	• When recording the strength of different materials, put results into a table that has been developed with help • When presenting data on the size of populations in different habitats, present data in a bar chart and a table and say which is clearest and why • When presenting their ideas, use arrows to show all the places where heat can be lost from a house	• When making observations about different materials, use appropriate describing words; for example, rough/smooth, waterproof/not waterproof, shiny/dull	• When researching materials, find uses for materials like carbon and aluminium when provided with links to suitable internet sites • When studying living things, use the index in a book to find the page about a given topic; for example, blood/the heart/the brain • When gathering information about heat, highlight given words in a text; for example, conduction, convection	• When surveying a habitat, work individually and then collaboratively and compare the number of observations collected • When investigating the rules of reflection, state how it was helpful to compare findings with those of others
Level 2 Learning targets While learning about …pupils can	• Present ideas with help using simple tables, charts or diagrams	• Use simple scientific words to describe their ideas and observations	• Find things out when guided using books or computers	• Say how others have helped them when working together in a group

00061-2010BKT-EN

Level 1 APP assessment criteria	• Present evidence they have collected in templates provided for them	• Use everyday terms to describe simple features or actions of objects, living things or events they observe • Communicate simple features or components of objects, living things and events they have observed in appropriate forms	• Communicate simple features or components of objects, living things or events they have observed in appropriate forms	• Share their own ideas and listen to the ideas of others

5.4 Assessment Focus 4: Using investigative approaches

AF4 Thread	To plan appropriate scientific investigations effectively	To identify and manipulate variables within the context of an investigation	To support the gathering of evidence through collection of precise and reliable data	To be aware of the risks associated with the investigative process
APP Level 8 assessment criteria	• Justify their choice of strategies for investigating different kinds of scientific questions, using scientific knowledge and understanding		• Choose and justify data collection methods that minimise error, and produce precise and reliable data	• Adapt their approaches to practical work to control risk by consulting appropriate resources and expert advice
Examples of some contexts to support lesson planning	• When planning an investigation: – justify the choice of method for measuring the rate of reaction between acid and calcium carbonate – explain the choice of light gates when measuring velocity of a toy car – use secondary data to back up the case for immunisation			• Review the approach after considering a range of safety information when planning a practical investigation into: – EMF values – working with living organisms – flame testing
Level 8 Learning targets While learning about … pupils can	• Explain why a particular method has been chosen to answer any scientific question		• Justify their chosen method in terms of collecting reliable and precise data	• Change an experimental approach in order to control risks that have been identified from other sources

00061-2010BKT-EN

Level 7 APP assessment criteria	• Formulate questions or ideas that can be investigated by synthesising information from a range of sources	• Identify key variables in complex contexts, explaining why some cannot readily be controlled, and plan appropriate approaches to investigations to take account of this	• Explain how to take account of sources of error in order to collect reliable data	• Recognise the need for risk assessments and consult, and act on, appropriate sources of information
Examples of some contexts to support lesson planning	• After observing a phenomenon, use a variety of sources to inform planning: – how to improve the Visking tubing model to demonstrate digestion and absorption of starch – investigate how matter is conserved in a reaction – the most appropriate method to determine the effect of available energy sources on the distribution and types of plants and animals	• Identify variables which cannot be controlled when investigating: – rates of respiration in seeds – the strength of an electromagnet – rates of reaction between acid and calcium carbonate	• While planning: – an investigation on animal behaviour – an investigation into melting and boiling points of different substances – an investigation into the energy in different foods explain how to try to control sources of error	• While using the resources available to them (technician, teacher, hazards posters, etc.) ensure work is carried out safely when: – handling and storing microbes – extracting chlorophyll and using flammable liquids – carrying out electrolysis
Level 7 Learning targets While learning about … pupils can	• Having considered information from a variety of sources, come up with a question or idea to investigate	• Plan for investigations, taking into account those variables that cannot be controlled, and include ways of minimising the effect of these	• Explain why the data that can be collected may be inconsistent • Explain what they can do to make the data more reliable	• Consult other sources of information to check that they are working as safely as possible and inform their risk assessment skills

00061-2010BKT-EN

Level 6 APP assessment criteria	• Collect data, choosing appropriate ranges, numbers and values for measurements and observations	• Apply scientific knowledge and understanding in the planning of investigations, identifying significant variables and recognising which are independent and which are dependent • Justify their choices of data collection method and proposed number of observations and measurements		• Independently recognise a range of familiar risks and take action to control them
Examples of some contexts to support lesson planning	• Use knowledge and understanding to decide on appropriate measurements and ranges when investigating: – enzyme activity at different temperatures – temperatures of solvent to be able to see a pattern when investigating solubility – the path of light through materials of different densities			• When working in a laboratory: – keep a tidy work space – avoid burning skin on hot tripods – collect and put away all equipment
Level 6 Learning targets While learning about…pupils can	• Change the value of the independent variable in their plan and explain why they chose a particular range and number so that they could collect enough data	• Explain the difference between the independent and dependent variables used in their investigations • Explain their choice: – for how they will collect the data – regarding the number of measurements they will take		• Work out for themselves when doing an experiment what the potential for harm is, by thinking ahead and taking action to avoid the risk

Level 5 APP assessment criteria	• Explain why particular pieces of equipment or information sources are appropriate for the questions or ideas under investigation	• Recognise significant variables in investigations, selecting the most suitable to investigate	• Repeat sets of observations or measurements where appropriate, selecting suitable ranges and intervals	• Make, and act on, suggestions to control obvious risks to themselves and others
Examples of some contexts to support lesson planning	• Use appropriate information or equipment to: – research adaptation of sensory organs in different animals – explain why it is more appropriate to use a temperature sensor to measure ambient temperature over 24 hours – explain why digital ammeters are more suitable than analogue ones for battery-powered circuits	• Identify the most significant variables to investigate when: – testing antacids – testing the activity of different enzymes – testing the amount of energy in different energy sources	• When investigating: – respiration in seeds – volumes of acid and alkali needed for neutralisation – the distance travelled by a car down a ramp at different angles decide the range of measurements to be taken and whether to repeat any observations	• When making suggestions about safe working, include some of the following: – tying hair back – wearing safety glasses – standing up when carrying out experiments – putting bags out of the way
Level 5 Learning targets While learning about…pupils can	• Explain why particular pieces of equipment or information sources are appropriate for the questions or ideas under investigation	• Recognise significant variables in investigations, selecting the most suitable to investigate	• Repeat sets of observations or measurements where appropriate, selecting suitable ranges and intervals	• Make, and act on, suggestions to control obvious risks to themselves and others

00061-2010BKT-EN

Level 4 APP assessment criteria	• Select appropriate equipment or information sources to address specific questions or ideas under investigation	• Decide when it is appropriate to carry out fair tests in investigations	• Make sets of observations or measurements, identifying the ranges and intervals used	• Identify possible risks to themselves and others
Examples of some contexts to support lesson planning	• When investigating: – the dietary needs of different groups of people – the separation of mixtures – the design of a circuit to serve a purpose select the best information or equipment	• A fair test is decided upon when investigating: – differences in heart rate in boys and girls – dissolving salts/sugars – burning different fuels	• While: – measuring height and arm span – matching colours of indicator to strength of acid or alkali – stretching a spring between values record observations or measurements, stating the lowest and highest measurement and how many measurements you are taking	• Spot the hazards in a given laboratory scenario • Identify hazards from hazard symbols on acids and alkalis
Level 4 Learning targets While learning about…pupils can	• Choose the best equipment to investigate a question or idea • Choose the best information to investigate a question or idea	• Decide whether a fair test is the best way to investigate something	• Make observations or measurements and say what the range and intervals are	• Identify when/how someone might be harmed when doing an experiment

00061-2010BKT-EN

Level 3 APP assessment criteria	• Select equipment or information sources from those provided to address a question or idea under investigation	• Identify one or more control variables in investigations from those provided	• Make some accurate observations or whole number measurements relevant to questions or ideas under investigation	• Recognise obvious risks when prompted
Examples of some contexts to support lesson planning	• While investigating: – how lack of water or light affects plant growth – evaporation of water – brightness of bulbs in a circuit select appropriate equipment	• While investigating: – melting different types of chocolate – friction on different surfaces – rate of growth of seedlings identify at least one factor to keep the same	• While investigating: – a plant growing – a range of irreversible chemical reactions – light falling on transparent, translucent and opaque objects make accurate observations or measurements	• Use a 'spot the hazard' activity, but with prompts
Level 3 Learning targets While learning about…pupils can	• Choose from a list (set) of equipment what items they would use to investigate a question or idea • Choose what content they would use from some information provided to investigate a question or idea	• Choose from a list at least one variable that needs to be kept the same in their investigation to make it a fair test	• With help, say what has been observed (accurately) • Measure accurately using whole number (+/-) measurements	• Recognise why instructions keep them and others safe

00061-2010BKT-EN

Level 2 APP assessment criteria	• Correctly use equipment provided to make valid observations and measurements	• Identify things to measure or observe that are relevant to the question or idea they are investigating	• Make some suggestions about how to find things out or how to collect data to answer a question	
Examples of some contexts to support lesson planning	• While: – observing which seeds grow the fastest – deciding which material reflects light best – finding out which sound is the loudest the correct equipment is used to measure and observe	• While: – choosing which container holds the most liquid – predicting whether a simple circuit works by observing the lamp – mixing chemicals and making observations of changes equipment is used correctly and observations are made	• While discussing any of the following: – which tree is this leaf from? – how long does it take for ice to melt? – is my shadow the same all day? make appropriate suggestions about finding things out and collecting data	
Level 2 Learning targets While learning about…pupils can	• Have their own ideas about how to find things out, or how to collect data to answer a question or idea they are investigating	• In their investigation with support: – say what to look for – say what to measure	• Use books/ICT and ask questions to find things out • Make measurements using standard and non-standard equipment	

Level 1 APP assessment criteria	• Respond to prompts by making some simple suggestions about how to find an answer or make observations		• Use their senses and simple equipment to make observations	

00061-2010BKT-EN

5.5 Assessment Focus 5: Working critically with evidence

AF5 Thread	Evaluation of the planning and implementation of scientific investigations	Consideration of errors and anomalies	Processing and analysing data to support the evaluation process and draw conclusions	Explanation and evaluation of evidence to support the scientific process
Level 8 APP assessment criteria	• Suggest and justify improvements to experimental procedures using detailed scientific knowledge and understanding • Suggest coherent strategies to take particular investigations further	• Propose scientific explanations for unexpected observations or measurements, making allowances for anomalies	• Process data, including using multi-step calculations and compound measures, to identify complex relationships between variables	• Critically interpret, evaluate and synthesise conflicting evidence
Examples of some contexts to support lesson planning	• When observing human body language in different situations, for example in the school canteen or in the supermarket, pupils devise qualitative and quantitative methods to record this and explain differences in behaviour • When explaining chemical reactions, pupils apply their understanding of chemical bonds to predict the behaviour of materials • While investigating and analysing quantitatively the noise pollution from technological applications such as headsets or earphones, suggest ways to extend the investigation	• When investigating the behaviour of organisms, compare proposed or actual data collection by others for the same investigation and how the collection has been directed by the way the investigation was planned • When investigating drug trials/placebo effects, discuss how to evaluate an investigation for unexplored variables and how this might raise uncertainty about conclusions drawn • When explaining noise pollution, explore the process of a randomised control trial	• After carrying out experiments in behaviour, structure discussions to explore how strongly the conclusions can be based on the primary evidence alone • When considering rates of reaction, construct a graph using an inverse function and use this graph to draw conclusions • When studying sound, produce a considered and evidence-supported response to the assertion that, although we have become better at producing sound, we are worse at managing it	• When carrying out research into claims made in the media and scientific articles, devise criteria and evaluate claims, for example, allowing pregnancies of 'designer siblings' to provide organs or tissues for transplantation • When considering and evaluating evidence from a variety of sources, for example on the use of the MMR vaccination, justify or discount sources of evidence as valid/invalid using their scientific knowledge and understanding

00061-2010BKT-EN

				• When constructing and presenting a complex scientific argument, for example in the context of managing the environmental impact of an airport development plan, analyse evidence to persuade a specific audience
Level 8 Learning targets While learning about …pupils can	• Justify improvements to a plan using detailed knowledge and understanding • Suggest a well thought out strategy to take the investigation further	• Offer a scientific explanation for unexpected data • Reduce the effect of random error through discounting or re-measuring anomalies • Identify systematic error through collaborative working	• Process data using multi-step calculations • Use compound measures effectively • Identify complex relationships between variables	• Analyse the evidence from all possible interpretations • Synthesise evidence from a range of sources and contexts • Use conflicting evidence effectively

Level 7 APP assessment criteria	• Explain ways of modifying working methods to improve reliability	• Assess the strength of evidence, deciding whether it is sufficient to support a conclusion • Explain ways of modifying working methods to improve reliability	• Assess the strength of evidence, deciding whether it is sufficient to support a conclusion	• Explain how data can be interpreted in different ways and how unexpected outcomes could be significant • Identify quantitative relationships between variables, using them to inform conclusions and make further predictions
Examples of some contexts to support lesson planning	• When using a range of instruments to collect local data over a longer timescale, for example over a term, and using it to model the global situation, for example acidity of rain, levels of carbon monoxide and dioxide, explain how limitations may have led to inconsistencies • When evaluating the efficiency of a chemical process by calculating yields from evidence gathered, explain how planning can be changed to improve validity through increased reliability and accuracy • Compare some of the scientifically accepted explanations for geological changes and what evidence would be needed to disprove them	• When using a range of instruments to collect local data over a longer timescale, for example over a term, and using it to model the global situation, for example acidity of rain, levels of carbon monoxide and dioxide, consider how anomalies may impact on their conclusions • When evaluating the efficiency of a chemical process by calculating yields from evidence gathered, plot raw data as well as mean values on graphs to demonstrate spread • Compare some of the scientifically accepted explanations for geological changes and what evidence would be needed to disprove them	• When using a range of instruments to collect local data over a longer timescale, for example over a term, and using it to model the global situation, for example. acidity of rain, levels of carbon monoxide and dioxide, compare their data with secondary evidence and explain any conflicting evidence • When evaluating the efficiency of a chemical process by calculating yields from evidence gathered, pupils peer-review the conclusions drawn • Compare some of the scientifically accepted explanations for geological changes and what evidence would be needed to disprove them	• When considering data that has been used to make a biased claim, for example in make-up advertisements, or for slimming products, explain how data can be interpreted in various different ways • Given data on a range of homeopathic remedies, pupils can use the data to decide whether there is a quantitative relationship between concentration and effectiveness • Compare a good and a less satisfactory plan for controlling risk, and explore the difference between perceived and actual risk

00061-2010BKT-EN

Level 7 Learning targets While learning about …pupils can	• Explain how planning can be changed to improve validity through increased reliability and accuracy • Explain how limitations in investigations may have led to inconsistencies • Explain how improvements to planning will lead to the collection of more valid data	• Consider how anomalies may impact upon the conclusion • Plot raw data as well as mean values on graphs to demonstrate spread • Comment on the spread of data in terms of accuracy and precision	• Assess the quality and quantity of evidence to make a valid conclusion • Use conflicting evidence effectively • Critically evaluate the conclusions drawn by others	• Explain how data can be interpreted in different ways • Recognise the significance of unexpected outcomes • Identify quantitative relationships between variables • Use evidence to make and explain further predictions

Level 6 APP assessment criteria	• Make valid comments on the quality of their data		• Select and manipulate data and information and use them to contribute to conclusions • Draw conclusions that are consistent with the evidence they have collected and explain them using scientific knowledge and understanding • Make valid comments on the quality of their data	• Suggest reasons based on scientific knowledge and understanding for any limitations or inconsistencies in evidence collected
Examples of some contexts to support lesson planning	• When researching using the internet about the discovery of a new species/order, for example the order *Mantophasmatodea* (gladiator insects), pupils decide how their methods could lead to inaccuracies in the data collected • When investigating the effect of temperature on solubility, comment on how methods used can generate data that might not be reliable or accurate, for example how difficult it is to take the temperature at exactly the same time as observing • When investigating the stopping distance/effect of friction for a moving object, pupils consider their results and comment on whether they have collected enough data to come to a reliable conclusion	• When investigating enzyme function, evaluate whether the selection and management of variables has affected the pattern of results • When investigating a wide range of reactions, classify and identify common features linked to their formulae, names or behaviour and explain any anomalous results using scientific knowledge and understanding • When investigating the effects of pressure, explain how repeating results can lead to the identification of anomalous results	• When presenting scientific arguments for a specific audience around a controversial issue, for example using role-play in exploring the smoking ban in public places, pupils explain how the selection or rejection of data can lead to different conclusions, using scientific knowledge and understanding • When explaining the relationship between enzyme effectiveness and temperature, select the most relevant data to make a conclusion • When considering evidence that supports or negates an argument, for example about the cost-effectiveness of soundproofing a house, explain how the selection or rejection of data can lead to different conclusions, using scientific knowledge and understanding	• When using evidence generated from experiments on photosynthesis, evaluate the validity, reliability and accuracy using their scientific knowledge and understanding • When comparing some of the scientifically accepted explanations for geological changes, highlight the inconsistencies and inaccuracies of the data • When investigating how sound waves travel in different mediums, use discussions to evaluate others' conclusions, by commenting on how reliable the range of data is, taking into consideration: – number of repeats – number of data points – choice of equipment – procedure

00061-2010BKT-EN

Level 6 Learning targets While learning about …pupils can	• Describe how the plan gives reliable and accurate collection of data • Decide how their methods could lead to inaccuracies in the data collected • Comment on whether they have collected enough data to come to a reliable conclusion	• Explain any anomalous results using scientific knowledge and understanding • Explain how repeating results can lead to the identification of anomalous results • Explain why results might be different from their prediction	• Select the most relevant data to reach a conclusion • Explain how the selection or rejection of data can lead to different conclusions, using scientific knowledge and understanding	• Explain inconsistencies in the data, using scientific knowledge and understanding • Comment on how reliable the range of data is, taking into consideration: – number of repeats – number of data points – choice of equipment – procedure

Level 5 APP assessment criteria	• Evaluate the effectiveness of their working methods, making practical suggestions for improving them	• Provide straightforward explanations for differences in repeated observations or measurements	• Draw valid conclusions that utilise more than one piece of supporting evidence, including numerical data and line graphs • Interpret data in a variety of formats, recognising obvious inconsistencies	
Examples of some contexts to support lesson planning	• When sampling the population of daisies on a field, explain how to ensure there is a random but representative sample • When investigating the solubility of a range of solutes, suggest that it would be better to weigh the solute rather than count the number of spatulas of solute added • When investigating the strength of different materials and as a result of peer review, pupils suggest how to improve their planning	• When exploring sources of evidence related to a controversial social behaviour issue, for example, knife crime, underage drinking, bullying, develop clear criteria to enable them to recognise whether data does not fit a pattern or trend • When measuring solubility: – notice if a particular value does not fit the pattern – use the term 'anomalous' correctly – suggest that the anomaly might be caused by using too much or too little solute • When learning about timescales involved in the development of the Earth, discuss the nature of the scientific data that is used as evidence	• When investigating the transfer of energy linked to evaporation from moist surfaces, draw conclusions about how organisms control temperature, using more than one piece of evidence • Discuss how manipulating a model or using an analogy could clarify an explanation of a separating technique • When describing patterns within the solar system, use secondary data as evidence to justify their conclusions	

00061-2010BKT-EN

Level 5 Learning targets While learning about…pupils can	• Evaluate the method used to improve planning • Discuss the strengths and weaknesses of their planning with others • Consider whether results are reliable • Describe practical suggestions that could improve planning to produce better results	• Recognise data that does not fit a pattern or trend • Use the term 'anomalous result' correctly • Recognise anomalous results in tables, charts and graphs • Decide whether data matches predictions made	• Use more than one piece of evidence when forming a conclusion • Use data, charts and graphs from primary and secondary evidence to justify their conclusion • Look for alternative conclusions the data can present	

Level 4 APP assessment criteria	• Suggest improvements to their working methods, giving reasons		• Identify patterns in data presented in various formats, including line graphs • Draw straightforward conclusions from data presented in various formats	• Identify scientific evidence they have used in drawing conclusions
Examples of some contexts to support lesson planning	• When carrying out a survey of the school grounds, identify whether a sample is representative of the whole field • When listening to two ways of planning an investigation, for example separating substances, suggest one aspect from each to include in their final plan • When investigating the energy content of fuels, highlight that the equipment should be protected from draughts because sometimes the flame doesn't reach the test tube		• When comparing the advantages and disadvantages of innate and learned responses, for example in pigs, form conclusions from results • When exploring to what extent materials can be classified by identifying their particular properties, identify which evidence they have used to form their conclusions • When investigating the effect of spreading a force out over a greater area, describe a relationship in the data and make a conclusion from results	• When researching the link between the distribution of dark fur on the paws, tail and face of Siamese cats and where the body is cool, explain the link between the evidence and the conclusion • When considering states of matter, explain what is between the particles and compare the strengths and weaknesses of the particle model • When learning about noise pollution and hazards related to high levels of sound, use evidence to support personal viewpoints
Level 4 Learning targets While learning about …pupils can	• Suggest more than one sensible improvement to planning • Give a sensible reason for making an improvement to planning		• Describe a relationship in data to: – form a conclusion from results – identify which evidence they have used to form their conclusion	• State the evidence used in making their conclusion

00061-2010BKT-EN

Level 3 APP assessment criteria	• Suggest improvements to their working methods		• Identify straightforward patterns in observations or in data presented in various formats, including tables, pie and bar charts • Describe what they have found out in experiments or investigations, linking cause and effect	
Examples of some contexts to support lesson planning	• When comparing the energy content of different foods, discuss problems with the investigation: – discuss problems when investigating the time taken to dissolve different – sized indigestion tablets – pupils suggest improvements to their planning – discuss problems when investigating the best insulator – pupils identify the need to keep the same thickness		• When comparing the energy content of different foods, identify which food was the source of the most energy • When investigating the time taken to dissolve different-sized indigestion tablets, link the time taken to dissolve to the size of the pieces of tablets • When investigating insulators, identify which insulators are the best	
Level 3 Learning targets While learning about …pupils can	• Talk about problems they have had with their investigations • Suggest an improvement to planning		• Describe results from observations and data • Link a cause to the effect they see in results • Describe what has been found out in the investigation and why • Identify simple patterns in data, charts and graphs	

Level 2 APP assessment criteria	• Say whether what happened was what they expected		• Say what happened in their experiment or investigation	• Respond to prompts to suggest different ways they could have done things
Examples of some contexts to support lesson planning	• When investigating reaction times, for example, dropping a ruler, state what went well and what didn't go well • When using the Concept cartoon™ Snowman, suggest ideas for carrying out an investigation • When investigating which size of paper cone allows the sand to fall the fastest, suggest things which could have been done differently		• When investigating reaction times, for example dropping a ruler, state what happened • When using the Concept cartoon™ Snowman, state what has happened • When investigating which size of paper cone allows sand to fall fastest, state what happened	• When investigating reaction times, for example dropping a ruler, state how to collect the evidence/data differently • When using the Concept cartoon™ Snowman, suggest ideas about what would make their investigations fair • When investigating which size of paper cone allows sand to fall fastest, suggest ways to collect data differently
Level 2 Learning targets While learning about …pupils can	• Say what went well and what didn't go well • Suggest ways that they could have done things differently with help • Suggest what to do next		• Say what happened in an experiment or investigation	• Say how they can collect the evidence/data differently • Say what made their investigation fair or not fair

Level 1 APP assessment criteria			• Respond to prompts to say what happened	• Say what has changed when observing objects, living things or events

00061-2010BKT-EN

6. Learning targets linked to levels

Another way of setting Learning targets is to base them on each attainment level. In sections 6.1–6.7 there are seven tables, each showing Learning targets associated with the Assessment Focus related to a single level between level 2 and level 8.

6.1 Learning targets linked to level 2

AF1 Thread	Using models for and in explanations	Weighing up evidence to construct arguments and explanations	The process of developing ideas including the role of the scientific community	Provisional nature of scientific evidence
Level 2 APP assessment criteria		• Make comparisons between basic features or components of objects, living things or events • Sort and group objects, living things or events on the basis of what they have observed	• Draw on their observations and ideas to offer answers to questions • Respond to suggestions to identify some evidence (in the form of information, observations or measurements) needed to answer a question	
Level 2 Learning targets While learning about … pupils can		• Compare features or components of objects, living things or events • Use observations to group objects, living things or events	• Use what they see and their own ideas to offer answers to questions • Use help to identify evidence needed to answer a question	

00061-2010BKT-EN

AF2 Thread	Effect of societal norms (political, social, cultural, economic) on science	Creative use of scientific ideas to bring about technological developments	Implications, benefits and drawbacks of scientific and technological development of society and the environment	How science relates to jobs and roles
Level 2 APP assessment criteria			• Identify scientific or technological phenomena and say whether or not they are helpful • Describe, in familiar contexts, how science helps people do things • Express personal feelings or opinions about scientific or technological phenomena	• Identify people who use science to help others
Level 2 Learning targets While learning about …pupils can			• Identify scientific or technological phenomena and say whether or not they are helpful • Describe, in familiar contexts, how science helps people do things • Express personal feelings or opinions about scientific or technological phenomena	• Identify people who use science to help others

AF3 Thread	Using appropriate presentation skills to enhance communication of scientific findings and arguments	Explaining ideas and evidence using appropriate conventions, terminology and symbols	Presenting a range of views judging any possible misrepresentation	Scientists communicating worldwide using conventions
Level 2 APP assessment criteria	• Present their ideas and evidence in appropriate ways	• Use simple scientific vocabulary to describe their ideas and observations	• Respond to prompts by using simple texts and electronic media to find information	• Work together on an experiment or investigation and recognise contributions made by others
Level 2 Learning targets While learning about…pupils can	• Present ideas with help using simple tables, charts or diagrams	• Use simple scientific words to describe their ideas and observations	• Find things out when guided using books or computers	• Say how others have helped them when working together in a group

AF4 Thread	To plan appropriate scientific investigations effectively	To identify and manipulate variables within the context of an investigation	To support the gathering of evidence through collection of precise and reliable data	To be aware of the risks associated with the investigative process
Level 2 APP assessment criteria	• Correctly use equipment provided to make valid observations and measurements	• Identify things to measure or observe that are relevant to the question or idea they are investigating	• Make some suggestions about how to find things out or how to collect data to answer a question	
Level 2 Learning targets While learning about…pupils can	• Have their own ideas about how to find things out, or how to collect data to answer a question or idea they are investigating	• In their investigation with support: – say what to look for – say what to measure	• Use books/ICT and ask questions to find things out • Make measurements using standard and non-standard equipment	

00061-2010BKT-EN

AF5 Thread	Evaluation of the planning and implementation of scientific investigations	Consideration of errors and anomalies	Processing and analysing data to support the evaluation process and draw conclusions	Explanation and evaluation of evidence to support the scientific process
Level 2 APP assessment criteria	• Say whether what happened was what they expected		• Say what happened in their experiment or investigation	• Respond to prompts to suggest different ways they could have done things
Level 2 Learning targets While learning about…pupils can	• Say what went well and what didn't go well • Suggest ways that they could have done things differently with help • Suggest what to do next		• Say what happened in an experiment or investigation	• Say how they can collect the evidence/data differently • Say what made their investigation fair or not fair

6.2 Learning targets linked to level 3

AF1 Thread	Using models for and in explanations	Weighing up evidence to construct arguments and explanations	The process of developing ideas including the role of the scientific community	Provisional nature of scientific evidence
Level 3 APP assessment criteria	• Represent things in the real world using simple physical models	• Identify differences, similarities or changes related to simple scientific ideas, processes or phenomena • Use straightforward scientific evidence to answer questions, or to support their findings	• Respond to ideas given to them to answer questions or suggest solutions to problems	
Level 3 Learning targets While learning about…pupils can	• Make a model to represent something that they have seen	• Identify differences, similarities or changes within things to do with science • Use scientific evidence and ideas to answer questions	• Answer questions/solve problems • Support what they have found out using their own experience	

00061-2010BKT-EN

AF2 Thread	Effect of societal norms (political, social, cultural, economic) on science	Creative use of scientific ideas to bring about technological developments	Implications, benefits and drawbacks of scientific and technological development of society and the environment	How science relates to jobs and roles
Level 3 APP assessment criteria			• Link applications to specific characteristics or properties • Explain the purposes of a variety of scientific or technological developments	• Identify aspects of our lives, or of the work that people do, which are based on scientific ideas
Level 3 Learning targets While learning about…pupils can			• Say how and why some science or technology is used • Say how and why some science or technology has changed	• Say how science is used in their life or in some jobs

AF3 Thread	Using appropriate presentation skills to enhance communication of scientific findings and arguments	Explaining ideas and evidence using appropriate conventions, terminology and symbols	Presenting a range of views judging any possible misrepresentation	Scientists communicating worldwide using conventions
Level 3 APP assessment criteria	• Present simple scientific data in more than one way, including via tables and bar charts	• Use scientific forms of language when communicating simple scientific ideas, processes or phenomena		• Identify simple advantages of working together on experiments or investigations
Level 3 Learning targets While learning about…pupils can	• Draw tables and bar charts	• Show what has been found out with some support • Use simple scientific words to describe or compare correctly • Include scientific terms and symbols (e.g. units)		• Say how working together has helped improve their learning

00061-2010BKT-EN

AF4 Thread	To plan appropriate scientific investigations effectively	To identify and manipulate variables within the context of an investigation	To support the gathering of evidence through collection of precise and reliable data	To be aware of the risks associated with the investigative process
Level 3 APP assessment criteria	• Select equipment or information sources from those provided to address a question or idea under investigation	• Identify one or more control variables in investigations from those provided	• Make some accurate observations or whole number measurements relevant to questions or ideas under investigation	• Recognise obvious risks when prompted
Level 3 Learning targets While learning about…pupils can	• Choose from a list (set) of equipment what items they would use to investigate a question or idea • Choose what content they would use from some information provided to investigate a question or idea	• Choose from a list at least one variable that needs to be kept the same in their investigation to make it a fair test	• With help, say what has been observed (accurately) • Measure accurately using whole numbers (+/–) measurements	• Recognise why instructions keep them and others safe

AF5 Thread	Evaluation of the planning and implementation of scientific investigations	Consideration of errors and anomalies	Processing and analysing data to support the evaluation process and draw conclusions	Explanation and evaluation of evidence to support the scientific process
Level 3 APP assessment criteria	• Suggest improvements to their working methods		• Identify straightforward patterns in observations or in data presented in various formats, including tables, pie and bar charts • Describe what they have found out in experiments or investigations, linking cause and effect	
Level 3 Learning targets While learning about…pupils can	• Talk about problems they have had with their investigations • Suggest an improvement to planning		• Describe results from observations and data • Link a cause to the effect they see in results • Describe what has been found out in the investigation and why • Identify simple patterns in data, charts and graphs	

6.3 Learning targets linked to level 4

AF1 Thread	Using models for and in explanations	Weighing up evidence to construct arguments and explanations	The process of developing ideas including the role of the scientific community	Provisional nature of scientific evidence
Level 4 APP assessment criteria	• Use simple models to describe scientific ideas	• Identify scientific evidence that is being used to support or refute ideas or arguments	• Use scientific ideas when describing simple processes or phenomena	• Identify scientific evidence that is being used to support or refute ideas or arguments
Level 4 Learning targets While learning about…pupils can	• Describe scientific ideas using scientific terms correctly • Describe scientific ideas using a physical model	• Recognise when scientific evidence is for or against an argument • Recognise when scientific evidence supports an idea or not	• Use scientific language to describe processes and observations • Use scientific facts when describing processes and observations	• Recognise when scientific evidence is for or against an argument • Recognise when scientific evidence supports an idea or not

AF2 Thread	Effect of societal norms (political, social, cultural, economic) on science	Creative use of scientific ideas to bring about technological developments	Implications, benefits and drawbacks of scientific and technological development of society and the environment	How science relates to jobs and roles
Level 4 APP assessment criteria			• Recognise applications of specific scientific ideas • Describe some simple positive and negative consequences of scientific and technological developments	• Identify aspects of science used within particular jobs or roles
Level 4 Learning targets While learning about…pupils can			• Identify the good and bad uses of technology and science • Identify how science is used in different ways in every day life	• Identify aspects of science in specific jobs • Identify how different jobs use science

00061-2010BKT-EN

AF3 Thread	Using appropriate presentation skills to enhance communication of scientific findings and arguments	Explaining ideas and evidence using appropriate conventions, terminology and symbols	Presenting a range of views judging any possible misrepresentation	Scientists communicating worldwide using conventions
Level 4 APP assessment criteria	• Select appropriate ways of presenting scientific data	• Use appropriate scientific forms of language to communicate scientific ideas, processes or phenomena • Use scientific and mathematical conventions when communicating information or ideas		
Level 4 Learning targets While learning about…pupils can	• Select useful ways of presenting information	• Use clear sentences, scientific words and symbols to describe simple ideas and observations		

AF4 Thread	To plan appropriate scientific investigations effectively	To identify and manipulate variables within the context of an investigation	To support the gathering of evidence through collection of precise and reliable data	To be aware of the risks associated with the investigative process
Level 4 APP assessment criteria	• Select appropriate equipment or information sources to address specific questions or ideas under investigation	• Decide when it is appropriate to carry out fair tests in investigations	• Make sets of observations or measurements, identifying the ranges and intervals used	• Identify possible risks to themselves and others
Level 4 Learning targets While learning about…pupils can	• Choose the best equipment to investigate a question or idea • Choose the best information to investigate a question or idea	• Decide whether a fair test is the best way to investigate something	• Make observations or measurements and say what the range and intervals are	• Identify when/how someone might be harmed when doing an experiment

AF5 Thread	Evaluation of the planning and implementation of scientific investigations	Consideration of errors and anomalies	Processing and analysing data to support the evaluation process and draw conclusions	Explanation and evaluation of evidence to support the scientific process
Level 4 APP assessment criteria	• Suggest improvements to their working methods, giving reasons		• Identify patterns in data presented in various formats, including line graphs • Draw straightforward conclusions from data presented in various formats	• Identify scientific evidence they have used in drawing conclusions
Level 4 Learning targets While learning about…pupils can	• Suggest more than one sensible improvement to planning • Give a sensible reason for making an improvement to planning		• Describe a relationship in data to: – form a conclusion from results – identify which evidence they have used to form their conclusion	• State the evidence used in making their conclusion

00061-2010BKT-EN

6.4 Learning targets linked to level 5

AF1 Thread	Using models for and in explanations	Weighing up evidence to construct arguments and explanations	The process of developing ideas including the role of the scientific community	Provisional nature of scientific evidence
Level 5 APP assessment criteria	• Use abstract ideas or models of more than one step when describing processes or phenomena • Explain processes or phenomena, suggest solutions to problems or answer questions by drawing on abstract ideas or models	• Identify the use of evidence and creative thinking by scientists in the development of scientific ideas		• Recognise scientific questions that do not yet have definitive answers
Level 5 Learning targets While learning about…pupils can	• Explain ideas or events using abstract models in familiar situations • Develop a description that uses abstract ideas or models of more than one step • Suggest solutions to problems using scientific ideas	• Show how scientists develop ideas by looking at a problem in different and imaginative ways and how this can be linked to the use of evidence or vice versa		• Give examples of instances where science cannot answer all our questions

00061-2010BKT-EN

AF2 Thread	Effect of societal norms (political, social, cultural, economic) on science	Creative use of scientific ideas to bring about technological developments	Implications, benefits and drawbacks of scientific and technological development of society and the environment	How science relates to jobs and roles
Level 5 APP assessment criteria	• Identify ethical or moral issues linked to scientific or technological developments • Describe different viewpoints a range of people may have about scientific or technological developments		• Link applications of science or technology to their underpinning scientific ideas • Indicate how scientific or technological developments may affect different groups of people in different ways	
Level 5 Learning targets While learning about…pupils can	• Consider whether it is right or wrong to use different types of technology and science • Describe the views people have about using science and technology		• Describe how science and technology affect people • Describe how scientific ideas have been developed and used	

AF3 Thread	Using appropriate presentation skills to enhance communication of scientific findings and arguments	Explaining ideas and evidence using appropriate conventions, terminology and symbols	Presenting a range of views judging any possible misrepresentation	Scientists communicating worldwide using conventions
Level 5 APP assessment criteria	• Decide on the most appropriate formats to present sets of scientific data, such as using line graphs for continuous variables	• Use appropriate scientific and mathematical conventions and terminology to communicate abstract ideas	• Distinguish between opinion and scientific evidence in contexts related to science, and use evidence rather than opinion to support or challenge scientific arguments	• Suggest how collaborative approaches to specific experiments or investigations may improve the evidence collected
Level 5 Learning targets While learning about…pupils can	• Select the most useful ways of presenting information, given a range of choices, for example when a line graph should be used rather than a bar chart	• Use clear sentences, scientific words and symbols correctly when describing abstract ideas and observations	• Support or challenge scientific arguments using evidence, not opinion	• Describe how working together could improve an investigation, for example by making it more reliable

00061-2010BKT-EN

AF4 Thread	To plan appropriate scientific investigations effectively	To identify and manipulate variables within the context of an investigation	To support the gathering of evidence through collection of precise and reliable data	To be aware of the risks associated with the investigative process
Level 5 APP assessment criteria	• Explain why particular pieces of equipment or information sources are appropriate for the questions or ideas under investigation	• Recognise significant variables in investigations, selecting the most suitable to investigate	• Repeat sets of observations or measurements where appropriate, selecting suitable ranges and intervals	• Make, and act on, suggestions to control obvious risks to themselves and others
Level 5 Learning targets While learning about…pupils can	• Explain why particular pieces of equipment or information sources are appropriate for the questions or ideas under investigation	• Recognise significant variables in investigations, selecting the most suitable to investigate	• Repeat sets of observations or measurements where appropriate, selecting suitable ranges and intervals	• Make, and act on, suggestions to control obvious risks to themselves and others

AF5 Thread	Evaluation of the planning and implementation of scientific investigations	Consideration of errors and anomalies	Processing and analysing data to support the evaluation process and draw conclusions	Explanation and evaluation of evidence to support the scientific process
Level 5 APP assessment criteria	• Evaluate the effectiveness of their working methods, making practical suggestions for improving them	• Provide straightforward explanations for differences in repeated observations or measurements	• Draw valid conclusions that utilise more than one piece of supporting evidence, including numerical data and line graphs • Interpret data in a variety of formats, recognising obvious inconsistencies	
Level 5 Learning targets While learning about…pupils can	• Evaluate the method used to improve planning • Discuss the strengths and weaknesses of their planning with others • Consider whether results are reliable • Describe practical suggestions that could improve planning to produce better results	• Recognise data that does not fit a pattern or trend • Use the term 'anomalous result' correctly • Recognise anomalous results in tables, charts and graphs • Decide whether data matches predictions made	• Use more than one piece of evidence when forming a conclusion • Use data, charts and graphs from primary and secondary evidence to justify their conclusion • Look for alternative conclusions the data can present	

00061-2010BKT-EN

6.5 Learning targets linked to level 6

AF1 Thread	Using models for and in explanations	Weighing up evidence to construct arguments and explanations	The process of developing ideas including the role of the scientific community	Provisional nature of scientific evidence
Level 6 APP assessment criteria	• Use abstract ideas or models or multiple factors when explaining processes or phenomena • Identify the strengths and weaknesses of particular models	• Describe some scientific evidence that supports or refutes particular ideas or arguments, including those in development	• Explain how new scientific evidence is discussed and interpreted by the scientific community and how this may lead to changes in scientific ideas	• Describe some scientific evidence that supports or refutes particular ideas or arguments, including those in development
Level 6 Learning targets While learning about…pupils can	• Explain logically ideas or events using abstract models in new situations • Say what is good or bad about a model • Select the most appropriate model to explain an idea	• Describe evidence which supports or disproves accepted or developing scientific ideas	• Explain how ideas change as people working in science discuss new evidence • Explain how ideas change as a result of interpreting evidence in different ways	• Describe evidence which supports or disproves accepted or developing scientific ideas

00061-2010BKT-EN

AF2 Thread	Effect of societal norms (political, social, cultural, economic) on science	Creative use of scientific ideas to bring about technological developments	Implications, benefits and drawbacks of scientific and technological development of society and the environment	How science relates to jobs and roles
Level 6 APP assessment criteria	• Describe how different decisions on the uses of scientific and technological developments may be made in different economic, social or cultural contexts	• Describe how particular scientific or technological developments have provided evidence to help scientists pose and answer further questions	• Explain how societies are affected by particular scientific applications or ideas	• Describe how aspects of science are applied in particular jobs or roles
Level 6 Learning targets While learning about …pupils can	• Describe how science and technology are used in different cultures • Describe how costs affect decisions on the uses of science and technology • Describe how science and technology affect societies	• Describe how evidence leads to further investigation • Describe how some science and technology developments have been used to ask and answer questions	• Explain how some science and technology have helped society	• Describe how people use science in their jobs • Describe how science is used in different jobs

AF3 Thread	Using appropriate presentation skills to enhance communication of scientific findings and arguments	Explaining ideas and evidence using appropriate conventions, terminology and symbols	Presenting a range of views judging any possible misrepresentation	Scientists communicating worldwide using conventions
Level 6 APP assessment criteria	• Choose forms to communicate qualitative or quantitative data appropriate to the data and the purpose of the communication	• Distinguish between data and information from primary sources, secondary sources and simulations, and present them in the most appropriate form	• Identify lack of balance in the presentation of information or evidence	
Level 6 Learning targets While learning about…pupils can	• Independently select the most useful ways to present qualitative and quantitative data • Explain which type of presentation is best for the data or the task	• Recognise the difference between a primary and a secondary source of evidence and information and know when the evidence comes from a simulation • Present the different kinds of evidence clearly	• Identify bias in information or evidence	

00061-2010BKT-EN

AF4 Thread	To plan appropriate scientific investigations effectively	To identify and manipulate variables within the context of an investigation	To support the gathering of evidence through collection of precise and reliable data	To be aware of the risks associated with the investigative process
Level 6 APP assessment criteria	• Collect data, choosing appropriate ranges, numbers and values for measurements and observations	• Apply scientific knowledge and understanding in the planning of investigations, identifying significant variables and recognising which are independent and which are dependent • Justify their choices of data collection method and proposed number of observations and measurements		• Independently recognise a range of familiar risks and take action to control them
Level 6 Learning targets While learning about…pupils can	• Change the value of the independent variable in their plan and explain why they chose a particular range and number so that they could collect enough data	• Explain the difference between the independent and dependent variables used in their investigations • Explain their choice: – for how they will collect the data – regarding the number of measurements they will take		• Work out for themselves when doing an experiment what the potential harm is, by thinking ahead and taking action to avoid the risk

00061-2010BKT-EN

AF5 Thread	Evaluation of the planning and implementation of scientific investigations	Consideration of errors and anomalies	Processing and analysing data to support the evaluation process and draw conclusions	Explanation and evaluation of evidence to support the scientific process
Level 6 APP assessment criteria	• Make valid comments on the quality of their data		• Select and manipulate data and information and use them to contribute to conclusions • Draw conclusions that are consistent with the evidence they have collected and explain them using scientific knowledge and understanding • Make valid comments on the quality of their data	• Suggest reasons based on scientific knowledge and understanding for any limitations or inconsistencies in evidence collected
Level 6 Learning targets While learning about…pupils can	• Describe how the plan gives reliable and accurate collection of data • Decide how their methods could lead to inaccuracies in the data collected • Comment on whether they have collected enough data to come to a reliable conclusion	• Explain any anomalous results using scientific knowledge and understanding • Explain how repeating results can lead to the identification of anomalous results • Explain why results might be different from their prediction	• Select the most relevant data to make a conclusion • Explain how the selection or rejection of data can lead to different conclusions, using scientific knowledge and understanding	• Explain inconsistencies in the data, using scientific knowledge and understanding • Comment on how reliable the range of data is, taking into consideration: – number of repeats – number of data points – choice of equipment – procedure

00061-2010BKT-EN

6.6 Learning targets linked to level 7

AF1 Thread	Using models for and in explanations	Weighing up evidence to construct arguments and explanations	The process of developing ideas including the role of the scientific community	Provisional nature of scientific evidence
Level 7 APP assessment criteria	• Make explicit connections between abstract ideas and/or models in explaining processes or phenomena	• Employ a systematic approach in deciding the relative importance of a number of scientific factors when explaining processes or phenomena	• Explain the processes by which ideas and evidence are accepted or rejected by the scientific community	• Explain how different pieces of evidence support accepted scientific ideas or contribute to questions that science cannot fully answer
Level 7 Learning targets While learning about…pupils can	• Develop original models to explain ideas and events • Justify the selection of a model to explain an idea • Explain events explicitly linking different ideas or models	• Consider and weigh up all the evidence available • Explain how and why some pieces of evidence are more important than others when explaining scientific ideas or events	• Explain how scientists accept or reject each others' ideas and evidence using peer review • Question assumptions, prejudice and bias in scientific evidence	• Explain how evidence has supported accepted scientific ideas • Explain how evidence can enable further questions to be asked • Explain how emerging evidence is helping to explain scientific theories

00061-2010BKT-EN

AF2 Thread	Effect of societal norms (political, social, cultural, economic) on science	Creative use of scientific ideas to bring about technological developments	Implications, benefits and drawbacks of scientific and technological development of society and the environment	How science relates to jobs and roles
Level 7 APP assessment criteria	• Suggest economic, ethical/moral, social or cultural arguments for and against scientific or technological developments • Suggest ways in which scientific and technological developments may be influenced	• Explain how creative thinking in science and technology generates ideas for future research and development	• Explain how scientific discoveries can change world views	
Level 7 Learning targets While learning about…pupils can	• Use economic, social or cultural arguments to justify scientific or technological developments • Argue how ethical and moral issues have influenced scientific and technological development • Evaluate how science and technology have impacted on different cultures • Argue how economics have influenced scientific and technological development • Suggest ways in which scientific and technological developments may be influenced by economic, cultural and societal factors	• Explain how creative thinking has developed science and technology • Explain how creative thinking generates ideas for future research	• Explain how science has changed the world around us	

AF3 Thread	Using appropriate presentation skills to enhance communication of scientific findings and arguments	Explaining ideas and evidence using appropriate conventions, terminology and symbols	Presenting a range of views judging any possible misrepresentation	Scientists communicating worldwide using conventions
Level 7 APP assessment criteria	• Effectively represent abstract ideas using appropriate symbols, flow diagrams and different kinds of graphs in presenting explanations and arguments		• Explain how information or evidence from various sources may have been manipulated in order to influence interpretation	• Explain how scientists with different specialisms and skills have contributed to particular scientific or technological developments
Level 7 Learning targets While learning about…pupils can	• Present explanations and arguments about abstract ideas using appropriate symbols, diagrams and graphs		• Explain how information and evidence may be manipulated to influence people	• Explain how scientists, who are experts in different areas, have worked together to contribute to an idea or development

AF4 Thread	To plan appropriate scientific investigations effectively	To identify and manipulate variables within the context of an investigation	To support the gathering of evidence through collection of precise and reliable data	To be aware of the risks associated with the investigative process
Level 7 APP assessment criteria	• Formulate questions or ideas that can be investigated by synthesising information from a range of sources	• Identify key variables in complex contexts, explaining why some cannot readily be controlled, and plan appropriate approaches to investigations to take account of this	• Explain how to take account of sources of error in order to collect reliable data	• Recognise the need for risk assessments and consult, and act on, appropriate sources of information
Level 7 Learning targets While learning about…pupils can	• Having considered information from a variety of different sources, come up with a question or idea to investigate	• Plan for investigations, taking into account those variables that cannot be controlled, and include ways of minimising the effect of these	• Explain why the data that can be collected may be inconsistent • Explain what they can do to make the data more reliable	• Consult other sources of information to check that they are working as safely as possible and inform their risk assessment skills

AF5 Thread	Evaluation of the planning and implementation of scientific investigations	Consideration of errors and anomalies	Processing and analysing data to support the evaluation process and draw conclusions	Explanation and evaluation of evidence to support the scientific process
Level 7 APP assessment criteria	• Explain ways of modifying working methods to improve reliability	• Assess the strength of evidence, deciding whether it is sufficient to support a conclusion • Explain ways of modifying working methods to improve reliability	• Assess the strength of evidence, deciding whether it is sufficient to support a conclusion	• Explain how data can be interpreted in different ways and how unexpected outcomes could be significant • Identify quantitative relationships between variables, using them to inform conclusions and make further predictions
Level 7 Learning targets While learning about…pupils can	• Explain how planning can be changed to improve validity through increased reliability and accuracy • Explain how limitations in investigations may have led to inconsistencies • Explain how improvements to planning will lead to the collection of more valid data	• Consider how anomalies may impact upon the conclusion • Plot raw data as well as mean values on graphs to demonstrate spread • Comment on the spread of data in terms of accuracy and precision	• Assess the quality and quantity of evidence to make a valid conclusion • Use conflicting evidence effectively • Critically evaluate the conclusions drawn by others	• Explain how data can be interpreted in different ways • Recognise the significance of unexpected outcomes • Identify quantitative relationships between variables • Use evidence to make and explain further predictions

6.7 Learning targets linked to level 8

AF1 Thread	Using models for and in explanations	Weighing up evidence to construct arguments and explanations	The process of developing ideas including the role of the scientific community	Provisional nature of scientific evidence
Level 8 APP assessment criteria	• Describe or explain processes or phenomena, logically and in detail, making use of abstract ideas and models from different areas of science	• Select and justify an appropriate approach to evaluating the relative importance of a number of different factors in explanations or arguments	• Analyse the development of scientific theories through the emergence of new, accepted ideas and evidence	
Level 8 Learning targets While learning about…pupils can	• Explain events logically linking different ideas or models beyond the level expected in normal science lessons • Use language that is ambitious, clear and relevant to the context • Use criteria to evaluate the appropriateness of a model	• Demonstrate a clear, critical stance on scientific ideas using evidence • Describe the limitations of evidence and the effect of this on the credibility of the argument • Justify an approach to evaluating an explanation or argument	• Analyse how a new theory came about over time by investigating the available evidence • Explain why scientific ideas are provisional • Recognise that different interpretations of evidence can lead to controversy	

00061-2010BKT-EN

AF2 Thread	Effect of societal norms (political, social, cultural, economic) on science	Creative use of scientific ideas to bring about technological developments	Implications, benefits and drawbacks of scientific and technological development of society and the environment	How science relates to jobs and roles
Level 8 APP assessment criteria	• Describe ways in which the values of a society influence the nature of the science developed in that society or period of history	• Explain the unintended consequences that may arise from scientific and technological developments	• Make balanced judgements about particular scientific or technological developments by evaluating the economic ethical/moral, social or cultural implications • Evaluate the effects of scientific or technological developments on society as a whole	
Level 8 Learning targets While learning about…pupils can	• Describe how values of society influence scientific or technological developments • Describe how society has caused changes in scientific or technological developments • Describe how science has changed through history	• Identify and explain how scientific and technological developments have been used in ways that were not intended	• Evaluate how and why scientific or technological developments have had an economic impact on society • Evaluate how and why scientific or technological developments have influenced different cultures • Evaluate how and why scientific or technological developments can have ethical or moral consequences • Evaluate how and why scientific and technological developments have influenced society • Evaluate the ethical and moral issues faced by people who use science or technology in their jobs	

AF3 Thread	Using appropriate presentation skills to enhance communication of scientific findings and arguments	Explaining ideas and evidence using appropriate conventions, terminology and symbols	Presenting a range of views judging any possible misrepresentation	Scientists communicating worldwide using conventions
Level 8 APP assessment criteria	• Present robust and well-structured explanations, arguments or counter-arguments in a variety of ways		• Critically evaluate information and evidence from various sources, explaining limitations, misrepresentation or lack of balance	• Suggest the specialisms and skills that would be needed to solve particular scientific problems or to generate particular new scientific or technological developments
Level 8 Learning targets While learning about…pupils can	• Present well-structured explanations, arguments or counter-arguments in a variety of ways that stand up to challenge		• Evaluate information to identify limitations, misrepresentation and/or bias	• Suggest which scientific specialisms would be required to solve specific problems or generate new scientific developments

AF4 Thread	To plan appropriate scientific investigations effectively	To identify and manipulate variables within the context of an investigation	To support the gathering of evidence through collection of precise and reliable data	To be aware of the risks associated with the investigative process
Level 8 APP assessment criteria	• Justify their choice of strategies for investigating different kinds of scientific questions, using scientific knowledge and understanding		• Choose and justify data collection methods that minimise error, and produce precise and reliable data	• Adapt their approaches to practical work to control risk by consulting appropriate resources and expert advice
Level 8 Learning targets While learning about…pupils can	• Explain why a particular method has been chosen to answer any scientific question		• Justify their chosen method in terms of collecting reliable and precise data	• Change an experimental approach in order to control risks that have been identified from other sources

00061-2010BKT-EN

AF5 Thread	Evaluation of the planning and implementation of scientific investigations	Consideration of errors and anomalies	Processing and analysing data to support the evaluation process and draw conclusions	Explanation and evaluation of evidence to support the scientific process
Level 8 APP assessment criteria	• Suggest and justify improvements to experimental procedures using detailed scientific knowledge and understanding • Suggest coherent strategies to take particular investigations further	• Propose scientific explanations for unexpected observations or measurements, making allowances for anomalies	• Process data, including using multi-step calculations and compound measures, to identify complex relationships between variables	• Critically interpret, evaluate and synthesise conflicting evidence
Level 8 Learning targets While learning about …pupils can	• Justify improvements to a plan using detailed knowledge and understanding • Suggest a well thought out strategy to take the investigation further	• Offer a scientific explanation for unexpected data • Reduce the effect of random error through discounting or re-measuring anomalies • Identify systematic error through collaborative working	• Process data using multi-step calculations • Use compound measures effectively • Identify complex relationships between variables	• Analyse the evidence from all possible interpretations • Synthesise evidence from a range of sources and contexts • Use conflicting evidence effectively

Appendices

Appendix 1: Glossary of terms

Achievement	The standards of attainment reached by pupils and the progress they have made to reach those standards
Attainment	The standard of academic attainment, typically shown by test and examination results
Assessment for Learning	The use of formative assessment practice on a daily basis to inform pupils' next steps in learning
Assessment of learning	The use of summative assessment to monitor and track pupils' expected progress
Classroom climate	The social, emotional and physical environment in which the learning takes place, created and planned for students by the school, teachers and peer group
Learning targets	Short-, medium- and longer-term learning goals which enable individual pupils to make their next steps in learning
Feedback	Written and/or oral information the learner receives about their current work that enables them to make the next steps in learning
Learning objectives	What a teacher wants pupils to be able to learn from the lesson or group of lessons
Learning outcomes	How the pupils will demonstrate their learning in a lesson
Success criteria	Information pupils can use to peer and/or self-assess their own progress when doing an activity measured against criteria
Modelling	Exemplifying a process that pupils are able to use independently in their learning
Progress	The extent to which pupils have progressed in their learning given their starting points and capabilities

Appendix 2: Examples of Learning mats

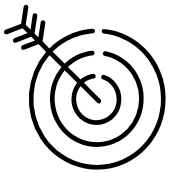
AF 2

How science and society influence each other

explain how some science and technology have helped society (L6)

describe how science and technology affect people (L5)

identify the good and bad uses of technology and science (L4)



My Learning target:

I need to be able to…

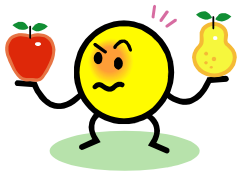
- **describe how** (say what and how I know) immunisation has affected how long people live
- say **how this has changed** in the last century
- give **examples**
- use my research evidence and **key scientific words** in my description

describe how scientific ideas have been developed and used (L5)

identify how science is used in different ways (L4)

00061-2010BKT-EN

AF 2

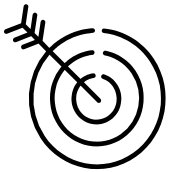


How science and society influence each other

describe how science and technology affects people (L5)

identify the good and bad uses of technology and science (L4)

say how and why some science or technology is used (L3)



My Learning target:

I need to be able to…

describe how scientific ideas have been developed and used (L5)

identify how science is used in different ways (L4)

say how and why some science or technology has changed (L3)

00061-2010BKT-EN

References and further reading

There is a wealth of support for developing aspects of *How Science Works* in the Framework section of the National Strategies web area; go to **www.standards.dcsf.gov.uk/nationalstrategies** and search for 'Framework for secondary science'.

Support materials in *Progressing to level 6 and beyond in science with added 'How Science Works'* can also be accessed by becoming a registered user and joining the course of the same name.

The language of measurement: Terminology used in school science investigations, ASE and Nuffield Foundation, 2010.

Suggested further reading

Clarke, S. (2003) *Enriching Feedback in the Primary Classroom*
Hodder Murray: ISBN: 0340872586

Clarke, S. (2005) *Formative Assessment in Action: Weaving the Elements Together*
Hodder Arnold: ISBN: 0340907827

Clarke, S. (2005) *Formative Assessment in the Secondary Classroom*
Hodder Murray: ISBN: 0340887664

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Field of sunflowers by Christophe Libert © SXC 2010

Sunflowers by Anders Rosenlund © SXC 2010

Sunflower seeds by Jason Anthony © SXC 2010

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