

Section 1: The National Curriculum programme of study for science

This section focuses on:

- 1.1 How the science programme of study (PoS) in the National Curriculum (NC) is structured;
- 1.2 How the sections in the science PoS for each key stage are split;
- 1.3 What the strands of knowledge, skills and understanding are;
- 1.4 How the attainment targets (ATs) are structured and which levels are expected of particular age groups.

1.1 HOW IS THE SCIENCE PROGRAMME OF STUDY STRUCTURED?

www.nc.uk.net/servlets/Subjects?Subject=Sc



Reading

The National Curriculum Handbook for primary teachers in England (1999)

Read the summary of each section of the NC PoS for science for each key stage to gain an overview of the knowledge, skills and understanding required.

Science, like the other NC subjects, has a programme of study (PoS) for key stages 1 to 4. The PoS is part of the statutory order, which means that it must be taught to all pupils. It describes the knowledge, skills and understanding which pupils should learn during each key stage. The key stage 1 PoS applies to Years 1 and 2, and the key stage 2 section applies to Years 3 to 6. The PoS for science is split into four sections:

- Sc1 Scientific enquiry;
- Sc2 Life processes and living things;
- Sc3 Materials and their properties;
- Sc4 Physical processes.

There is a separate curriculum for the foundation stage (age three to the end of the Reception Year), in which science is part of the area of learning 'knowledge and understanding of the world'. The key stage 1 PoS builds on the knowledge, skills and understanding developed during the foundation stage. The key stage 2 PoS, in turn, builds on key stage 1.

1.2 WHAT ARE THE CHARACTERISTICS OF THE SCIENCE PoS?

The science PoS for key stages 1 and 2 state that '*Teaching should ensure that scientific enquiry is taught through contexts taken from the sections on **life processes and living things, materials and their properties and physical processes***'.

Sc1 Scientific enquiry sets out the role of ideas and evidence in science and the investigative skills that children should develop, together with the knowledge and understanding set out in **Sc2 Life processes and living things, Sc3 Materials and their properties** and **Sc4 Physical processes**. The children should **use** these skills in order to acquire that knowledge and understanding. The breadth of study at the end of the key stage 1 and key stage 2 PoS indicate the **type** of contexts and experiences through which this knowledge, skills and understanding should be developed and the considerations that must be borne in mind, such as health and safety.

1.3 WHAT ARE THE STRANDS OF KNOWLEDGE, SKILLS AND UNDERSTANDING?

www.standards.dfee.gov.uk/schemes/science/ The contents of Sc1, Sc2, Sc3 and Sc4 are arranged in separate strands, each with its own heading.

Programme of study	Key stage 1 strands	Key stage 2 strands
Sc1 Scientific enquiry	Ideas and evidence in science Investigative skills (planning, obtaining and presenting evidence, considering evidence and evaluating)	Ideas and evidence in science Investigative skills (planning, obtaining and presenting evidence, considering evidence and evaluating)
Sc2 Life processes and living things	Life processes Humans and other animals Green plants Variation and classification Living things in their environment	Life processes Humans and other animals (nutrition, circulation, movement, growth and reproduction, health) Green plants (growth and nutrition, reproduction) Variation and classification Living things in their environment (adaptation, feeding relationships, micro-organisms)
Sc3 Materials and their properties	Grouping materials Changing materials	Grouping materials Changing materials Separating mixtures of materials
Sc4 Physical processes	Electricity Forces and motion Light and sound (light and dark, making and detecting sounds)	Electricity (simple circuits) Forces and motion (types of force) Light and sound (everyday effects of light, seeing, vibration and sound) The Earth and beyond (the Sun, Earth and Moon, periodic changes)

For more information, see Chapter 6: Section 2: Scientific knowledge and understanding and Section 3: Investigative skills

The PoS does not say when any particular content should be taught, nor is it a scheme of work. To help schools to plan their schemes of work for each subject, the Department for Education and Skills (DfES) and the Qualifications and Curriculum Authority (QCA) have developed non-statutory *Schemes of work for key stages 1 and 2*.



Optional Task

To increase your familiarity with the contents of the NC PoS for science, complete the chart on page 98.

Write:

- the attainment targets and headings (Sc1, Sc2, etc.) that could be taught through each of the activities listed on the chart;
- the numbers and strand headings for which the activity provides a context.

You will need to refer to the NC science PoS.

Note: Most activities will develop skills from Sc1 as well as knowledge and understanding from Sc2, Sc3 or Sc4.

I.4 WHAT ARE THE SCIENCE ATTAINMENT TARGETS (ATs)?



Reading

The National Curriculum attainment targets for science (1999), pp17–23.

For more information, see Chapter 2: Assessment, recording and reporting

As in the other subjects, ATs set out the levels to which children of different abilities should have developed knowledge, skills and understanding by the end of each key stage. Each AT relates to a section of the PoS and is graded into eight levels, the first six of which apply to primary school children. Each level gives a description of what a child should know and be able to do. These descriptions help the teacher to make judgements about a pupil's performance at the end of a key stage.

Key stage 1 children are expected to work within levels 1 to 3, with the expected attainment for the majority being level 2, with the higher-achieving children reaching level 3 and a few of exceptional achievement reaching level 4. Key stage 2 children are expected to work within levels 2 to 5, with the expected attainment of the majority being level 4 by the end of the key stage, the higher-achieving children reaching level 5 and a few of exceptional achievement reaching level 6.



Optional Task

Describe an activity that would help children to develop the following knowledge, skills and understanding at the given levels:

Sc1 Level 1: Describe simple features of objects observed.

Sc1 Level 4: Select suitable equipment and make a series of observations or measurements that are adequate for a task.

Sc2 Level 2: Sort living things into groups using simple features.

Sc3 Level 5: Describe some metallic properties.

Sc4 Level 3: Make simple generalisations about physical phenomena.

Note: You will need to refer to the NC attainment targets for science and to the science PoS. You will also find published science teaching resources useful (in books or on websites). You need not go into great detail about the activities (the level of detail of the activities described on the chart on page 98 can be used as a guide).

The National Curriculum programme of study for science

Activity	Key stage	Programme of study statement reference	Attainment target and strand reference
Placing small pots of butter and chocolate in a warm place, observing and recording any changes; placing the same materials in a refrigerator and repeating the observations and recordings.			
Observing a collection of familiar plants and identifying the stem, petals, roots and leaves. Commenting on the similarities and differences between a dandelion and a daffodil.			
Predicting which objects in a collection will be attracted by a magnet; testing the objects with a magnet. Explaining why they think some objects were attracted but not others.			
Placing spoons made of wood, plastic and metal (supervised) into pots of hot water and ice, feeling the handles of the spoons and recording observations. Using the observations to explain which materials are good or bad conductors of heat.			
Marking a spot outdoors on which to stand when measuring the lengths of their shadows at different times of the day. Drawing lines to show the directions of their shadows at different times of the day.			
Planning an investigation to find out which is the best material for a floor covering in a room for quiet study.			
Finding out about the idea that the lack of fresh fruit and vegetables in sailors' diets led to scurvy, how the idea was tested and how sailors' diets were altered as a result.			
Finding out whether all roses have the same number of petals: counting the petals on rose flower heads and recording the data using data-handling software and producing bar charts.			
Finding out about the factors which make sugar dissolve quickly and explaining their findings. Evaluating their investigations and suggesting ways to improve them.			
Using a force meter to weigh objects suspended in air and in water, comparing and explaining the results.			
Completing a chart to record observations of the materials from which different parts of the school building are made. Naming other materials they have seen used for those purposes, eg. plastic and metal for drainpipes, plastic, metal and wood for window frames.			
Making labelled drawings to show which objects in and around the school can be moved by pushing or pulling them, eg. doors, drawers, pull-along toys and tricycles.			
Exploring musical instruments and other sound-making devices and saying what has to be done to produce the sound eg. tapping/banging, blowing, shaking.			

This section focuses on:

- 2.1 The range and depth of scientific knowledge needed to teach the National Curriculum (NC) programme of study (PoS) for science;
- 2.2 How to identify any gaps in your own scientific subject knowledge;
- 2.3 How to respond with confidence to questions that children ask about science, recognising:
 - those that need to be looked up in books, CD-ROMs or on the internet;
 - those that can be demonstrated practically or explained with reference to concepts the children understand;
 - those that can be answered by investigation or experiment;
 - those to which there is no definitive answer.

2.1 DO I HAVE THE REQUIRED QUALIFICATIONS, AND RANGE AND DEPTH OF KNOWLEDGE AND UNDERSTANDING, TO TEACH SCIENCE IN PRIMARY SCHOOLS?

www.canteach.gov.uk/community/itt/requirements/index.htm

Since September 1998, anyone born on or after 1 September 1979 who enters an initial teacher training course is required to have attained a minimum of GCSE Grade C or its equivalent in science. There is no such requirement of anyone born before that date. Trainee teachers must also demonstrate the knowledge and understanding of science set out in the Professional Standards for Qualified Teacher Status. This provides a good guide to the range and depth of knowledge you will need in order to teach science confidently and competently. Some teachers might find these requirements rather daunting, especially if they qualified several years ago. The Optional Task on the next page will help you to assess your scientific knowledge and understanding and to set yourself targets for improving it. It is important that you understand the sections of the Standards that are related to any topic you teach.

2.2 HOW CAN I FILL THE GAPS IN MY SCIENTIFIC KNOWLEDGE AND UNDERSTANDING?

The following websites also provide useful information

Virtual Teacher Centre
www.vtc.ngfl.gov.uk/

The Association for Science Education
www.ase.org.uk/

Your preparation for teaching science will provide opportunities to increase your own scientific knowledge and understanding. There are a number of resources that are designed to increase your scientific knowledge, for example:

Primary science knowledge and understanding (Johnsey et al, 2002);
Schemes of work for key stages 1 and 2 (DfES/QCA);
Knowledge and understanding of science (NCC) (1992);
Meeting the standards in Primary science: a guide to the ITT NC (Newton, 2000).



Optional Task

- When beginning any new topic in science, assess your own knowledge and understanding of it against the *Professional Standards for Qualified Teacher Status*.
- Answer the questions in the table below (Developing your own knowledge and understanding of science).
- Read the appropriate sections of the *Professional Standards for Qualified Teacher Status*.
- Use the resources listed at the beginning of this section to gain an understanding of solids, liquids and gases.

Note: Make sure that you know if the change is reversible, whether it is a chemical or physical change and the differences between chemical and physical changes.

Developing your own knowledge and understanding of science

Write or make annotated drawings to answer the questions.

Use your knowledge of solids, liquids and gases and change of state to answer the following questions.

1. Why can you smell perfume in a room after the person wearing it has left?
2. After inflating a balloon, why do you need to tie its opening to keep in the air?
3. Why does an ice cube keep its shape when taken out of the mould, until it melts, and why does it not keep its shape when it melts?
4. Draw your prediction of the graph to show the change of temperature over time as an ice cube melts.
 - Take the temperature of an ice cube melting (eg. every five minutes).
 - Describe what you found out and explain your results.
 - Check all your answers using the resources suggested.

2.3 WHAT SHALL I DO WHEN I DON'T KNOW THE ANSWERS TO THE CHILDREN'S QUESTIONS?

It is useful to try out the planned activities to consider the ways in that they might arouse the children's curiosity. Think of the questions that might arise – eg. 'How does a magnet pick up a pin?' and 'How does an electric current travel along a wire?' – and try to answer them.

Even after careful preparation, you will be asked questions that you cannot answer! The examples below were asked by children during science lessons. Task 3 helps you to decide which questions **can** be answered, how to classify them according to the best way in which to answer them and what to do about the others. There is nothing wrong with admitting that you do not know the answer to a child's question but, if it can be answered, you need to develop strategies for finding the answer or for helping the child to find it.

www.shu.ac.uk/schools/scil

You need to decide when to give children the answer and when to encourage them to find it out for themselves. It can be off-putting, apart from not being feasible, if every single question prompts an investigation. If an investigation is feasible, you can help the children to turn their 'Why?' questions into 'Have you noticed...?', 'What can you find out about...?', 'What happens when...?' or 'Can you find a way to...?'



Optional Task

Enlarge the chart below (Children's questions), read the questions and complete the chart.

- Decide which questions do not have definitive answers and which ones can be answered.
- Indicate your approach to answering them. For example, look it up in a book or CD-ROM, eg. www.shu.ac.uk/schools/scil, observe or investigate. To help you to get started, some parts have been completed for you.

Children's questions

Question	Can it be answered?	Approach	Answer
Why can I see my reflection in a window when I go outside but not when I am in the classroom? (Age 5)	Yes	Investigate: look at reflections from outside when the classroom light is on and off; look at sheets of perspex both with and without a piece of paper behind them (try both black and white paper). When can you see your reflection?	Simple: You need something to stop you seeing through the glass (or perspex). Detailed: Reflected light from a person or object passes through transparent materials, but is reflected by shiny opaque materials.
How can we see big things when our eyes are so little? (Age 6)	Yes	Investigate: look through holes in paper (from close up and from a distance); look at a camera shutter.	
Why is the sky blue? (Age 8)	Yes	Look it up (a starting point is that light is made up of different colours).	
Are there other planets with people on them? (Age 9)			
Can snails see? (Age 10)			
Why do cars rust? (Age 11)			

This section focuses on:

- 3.1 The nature of science and the processes involved in scientific investigation;
- 3.2 The terms used in the National Curriculum (NC) to refer to investigative skills, and their meanings.

3.1 WHAT IS MEANT BY 'THE NATURE OF SCIENCE'?



Reading

See *Qualifying to Teach: Professional Standards for Qualified Teacher Status and Requirements for Initial Teacher Training (2002)*.

The revised *Standards for Qualified Teacher Status* require teachers to understand that:

- science is a way of making sense of natural phenomena and, as such, involves the interaction of an existing body of knowledge with the 'discovery' of new evidence, leading to a re-interpretation or explanation of phenomena and processes;
- scientific knowledge and explanations may change as new evidence is collected and thinking is challenged;
- science is a co-operative activity, which involves a worldwide community of scientists and others in developing more powerful ways of understanding the natural world;
- science does not explain every phenomenon;
- scientific knowledge and understanding can be used in solving a range of problems, but that the available scientific evidence is often limited, and its application to everyday problems often entails ethical or moral questions.

It goes on to indicate how this can be used to support the teaching of the programme of study (PoS) for key stages 1 and 2:

- the way in which scientific evidence relates to familiar phenomena, including personal health and the environment;
- ways of treating living things and the environment with care and sensitivity;
- the importance and value of science as a way of explaining many phenomena.

In practical terms, these statements mean:

- making science lessons relevant to children;
- helping them to realise the choices that they make in science and those that scientists make;
- how these choices affect their surroundings, animals and other people;
- talking about ways in which science is used to make technological things;
- making them aware of ways in which scientists have explained their observations and answered questions;
- encouraging them to explain their own observations or to make observations in order to answer a question.

3.2 DO I UNDERSTAND ALL THE TERMS USED IN THE NATIONAL CURRICULUM (NC) TO REFER TO INVESTIGATIVE SKILLS?

The following glossary explains some of the terms which appear in the revised *Standards for Qualified Teacher Status*:

Experiment:	A controlled test to see if there is any evidence to support a hypothesis .
Fair test:	A test in which variables are controlled in order to reduce any doubts about explanations of the results of the test.
Guess:	Speculation about the result of an experiment or investigation .
Hypothesis:	A tentative idea or explanation to be tested.
Investigation	Looking for evidence to support an explanation or idea.
Prediction:	A forecast of what will happen, based on prior knowledge.
Secondary source:	The results of someone else's investigation or experiment , information in a book or other source (not from first-hand experimentation or investigation).
Variable:	One of the factors in an investigation that changes. A categorical variable refers to categories such as eye colour or type of plant. A discrete variable is a number (eg. the number of paper clips a magnet will pick up). A continuous variable can be recorded numerically, but it belongs to a continuous scale (eg. increasing length or height, or temperature). A dependent variable changes according to another variable (eg. the length of a shadow might depend on the position of the Sun in the sky), whereas an independent variable is one which does not depend on anything else in the investigation (eg. the position of the Sun).



Optional Task

Briefly describe a science lesson either:

- in which key stage 2 children can plan a fair test to find the best way to keep an ice cube from melting if no refrigerator is available OR
- in which key stage 1 children can plan a fair test (with support) to find out which gloves will be best for keeping their hands warm. Describe any hypotheses that the children might put forward, what predictions might be made (and why), any variables to be controlled and what the children will observe and measure.

Read the Sc3 Materials and their properties in the NC PoS for science and make a note of the scientific knowledge and understanding that will be developed during the investigation.

- Describe the types of investigations the children are likely to suggest.
- Try them out.
- What results are the children likely to obtain?
- What conclusions can be drawn from the results?
- What secondary sources can be used to find out more?
- List the resources needed for the lesson.

This section focuses on:

- 4.1 The common errors that children make and the misconceptions they often have in science;
- 4.2 How to use skilfully framed open and closed (oral and written) questions to promote children's learning;
- 4.3 When and how to use effective exposition to promote children's scientific understanding;
- 4.4 The characteristics of interesting and inspiring lessons.

4.1 HOW CAN I FIND OUT ABOUT CHILDREN'S MISCONCEPTIONS IN SCIENCE?

Misconceptions is a term used for the incorrect explanations children (and adults) develop for the phenomena they observe. They are very often common-sense explanations – for example, water that appears on the outside of the can or glass in which there is a cold drink has come through the sides of the can or glass (the child is not aware of anywhere else it could have come from). The logic behind such common-sense explanations can help the teacher to address them. Children who think condensation comes from the drink in a container need to be made aware that there is water in the air (perhaps by observing a kettle boiling). Although children can have a variety of misconceptions, there are several very common ones and it is useful to be aware of them. You might also find that you have a few scientific misconceptions yourself. You could test yourself on the following, by explaining what is wrong with them:

'The coloured glass in a stained glass window changes the colour of the white light which shines through it.'

'A small piece of beech wood will float because it is light, but a large piece will sink because it is heavy.'

'Plant material is made from substances found in the soil, because plants get their food, via their roots, from the soil.'



Optional Task

Discuss with a science co-ordinator what kinds of discussions and activities could be included in your teaching in order to address each of the following common misconceptions.

- We see things because light comes from our eyes and lights them up.
- Grass is not a flowering plant.
- Sugar melts in water.
- Worms, snails and spiders are insects.
- People are not animals.
- Metal things sink.
- When a bulb is lit by a battery (or by mains electricity), the bulb uses up electricity.
- White or brightly coloured things and mirrors give off light and would help you to see in a dark place.
- Trees and bushes are not plants.
- For a moving object, such as a toy car, to carry on moving, you have to keep pushing (or pulling) it.

4.2 HOW CAN I USE OPEN AND CLOSED QUESTIONS TO PROMOTE CHILDREN'S LEARNING?



Reading

Qualifying to Teach: Professional Standards for Qualified Teacher Status and Requirements for Initial Teacher Training (2002).

A closed question can usually be answered fairly quickly, for example:

- *'Which is the heaviest piece of wood?'*
- *'How many legs does a spider have?'*
- *'Where did you place the two masses on the see-saw to balance it?'*
- *'What was the starting temperature of the water?'*
- *'Where did you find the woodlice?'*

Closed questions have their place – for example, in drawing together the results found by different groups during an investigation, or directing the children's observation.

An open question requires more thought, and the teacher should therefore allow the children longer to answer it – for example:

- *'If we move the model nearer to the torch, what might happen to its shadow?'*
- *'Why do you think we find so many woodlice under stones?'*
- *'What do you think will happen to the temperature of this hot water if we leave it in the classroom overnight?'*

For more information, see Chapter 6: Section 3: Investigative skills

Open questions are useful in discussing hypotheses, explaining the results of an investigation and drawing conclusions.

4.3 WHEN AND HOW SHOULD I USE EXPOSITION IN MY SCIENCE TEACHING?

www.sln.org

Exposition is often a valuable accompaniment to practical investigation. It can provide an introduction to an investigation and it can take the children's learning further than practical investigation alone.

Exposition is useful in:

- directing children to the most important points to observe or measure, such as where, exactly, on a can containing ice they can see and feel condensation;
- simplifying scientific ideas – for example, evaporation;
- breaking down complex ideas into small steps – for example, to help the children to understand the link between conduction of heat and what they feel when they touch things;
- using illustrations, models, analogies and demonstrations to make complex scientific phenomena comprehensible to children – for example, using a globe and a flashlight to explain how the Earth's orbit around the Sun influences the seasons;
- demonstrating a technique, such as how to use a thermometer safely;
- making use of secondary sources to demonstrate phenomena or techniques that are not possible in the classroom – for example, using websites such as that of Schools Online to compare the speeds of light and sound.

4.4 HOW DO I MAKE MY SCIENCE LESSONS INTERESTING AND INSPIRING?

www.teachingideas.co.uk/science/contents.htm

www.scienceyear.com/sciteach/index.html

It is important to make any science topic relevant to the children – for example:

- using a real-life starting point which is familiar to them;
- introducing something novel that will stimulate their interest;
- posing a problem to be solved;
- using the outdoor environment;
- using simulation;
- making an educational visit to a museum, mill, farm etc.;
- inviting a visiting speaker into school;
- using ICT.



Think About

- In the foundation stage, the children could be taken on a 'smelling walk' around the school. Ask them what they can smell in different places. Which smells do they like? Which do they not like? Note: the children should be warned not to smell unknown substances.
- In key stage 1, the children could be given a collection of clothes and asked to dress a shop dummy for different weather conditions and then to explain why they have chosen those clothes (eg. a raincoat and Wellington boots for wet weather, or a woollen sweater and thick coat for cold weather).
- In key stage 2, the children could watch videos of space rockets taking off and make notes about what they observe happening. They could send 'balloon rockets' across the room (balloons fixed to drinking straws which are threaded on to lengths of fishing line fastened from one wall to another), and then explain what made the balloons start moving and how to make them travel faster and further.



Optional Task

Read the extract on page 107 from Unit 4D of *A scheme of work for key stages 1 and 2: science* (1998).

List the closed and open questions you might ask, and at which points during the activity. List any uses of exposition and explain how they are helpful. List the ways in which the activities are made relevant to the children.

Add any other ideas you have to make science lessons inspiring and innovative.

Unit 4D: Solids, liquids and how they can be separated

Pupils learn:	Possible teaching activities
	Elicit the children's existing knowledge of materials by presenting them with a collection of solids and asking them to group them according to their own criteria, recording reasons for their choices. Revise language for describing properties of materials.
To identify solids and liquids; that there are liquids other than water.	Present the children with additional items for the collection, including liquids of differing viscosity, and ask them to divide them into two groups only. If necessary, supplement the examples with pictures. Discuss the groupings with the children, introducing the terms 'solid' and 'liquid' and ask children to re-group the items in this way. Ask the children to describe (by writing and drawing) as many differences and similarities as possible between solids and liquids. It may be helpful to ask questions (eg. Are all the liquids colourless? What happens to the liquid if you change the container it is in? Can you spill the solids? What happens if you tilt the bottle containing the liquid?) Draw the children's attention to particular properties. Extend the activity by presenting them with some 'difficult' items (eg. cotton wool, sponge, sand, rice), and ask them to classify them as solids or liquids.
To make careful observations and measurements of volume, recording them in tables and using them to draw conclusions; that liquids do not change in volume when they are poured into a different container.	Revise with the children how to measure volumes of liquids. Ask them to find out and record in a table what happens to shape and volume when liquids are poured from one container into a different shaped container. Talk with the children about what their results show and ask them to make use of them to formulate a generalisation.
That solids consisting of very small pieces behave like liquids in some ways.	Ask the children to explore and describe the ways in which powders and solids consisting of many small pieces (eg. rice, salt, sand) are different from, or similar to, liquids (eg. by tilting jars containing these materials, by trying to use sand to turn a water wheel, by sieving them through gauze).
That the same material can exist as both solid and liquid; that liquids can be changed to a solid by cooling and this is freezing or solidifying; that a solid can be changed to a liquid by heating and this is melting.	Ask the children when they have seen frozen water, and what conditions are necessary for water to freeze. Ask them to suggest how to make ice melt. Elicit examples of other familiar materials melting or solidifying (eg. wax running down the side of a candle, chocolate melting etc.), and let the children explore what happens to wax if it is held in the hand or put in a warm place. Ask them how to keep familiar materials (eg. ice, chocolate, butter) from melting and help them to relate these to temperature.
That different solids melt at different temperatures; that melting and solidifying or freezing are changes which can be reversed and are the reverse of each other.	Use secondary sources (eg. video, CD-ROM, pictures) to illustrate molten metals or molten lava. Emphasise that many materials have to be heated to very high temperatures before they melt. Ask the children to use secondary sources to find out more about melting metals and to record information about why this is a useful characteristic of metals.

(Science activities from *A scheme of work for key stages 1 and 2: science*, DfEE/QCA, 1998)

Chapter 6: Section 5: Scientific vocabulary and skills in recording, presenting and communicating

This section focuses on:

- 5.1 The scientific terms used in the National Curriculum (NC) programme of study (PoS) for key stages 1 and 2;
- 5.2 The range of methods children can use for recording and communicating in science.

5.1 DO I HAVE SUFFICIENT UNDERSTANDING OF SCIENTIFIC TERMS?

The terms that refer specifically to scientific investigation were addressed in Section 3: Investigative skills, which was about Sc1. You should also ensure that you know and understand the scientific vocabulary connected with Sc2, Sc3 and Sc4.

The accurate use of words is important in avoiding teaching in ways that contribute to children's misconceptions in science. For example, the use of 'disappear' to describe what happens when sugar dissolves in water is not helpful, since it suggests (or confirms the children's misconception) that the dissolved sugar no longer exists. Children should be encouraged to use accurate vocabulary as they progress from the foundation stage to key stage 1 and key stage 2. If, for example, the children say that objects 'stick' to a magnet, introduce the word 'pull' and even 'attract' by asking '*Which things does the magnet pull?*' This prepares the children for later work on magnetism as a force.

For more information, see Section 4:
Teaching methods for science

www.standards.dfes.gov.uk/schemes/science/

Each unit of *A scheme of work for key stages 1 and 2: science* has a list of scientific vocabulary to be taught, and indicates words that might cause confusion because their everyday or 'other subject' meanings differ from their scientific meanings.



Optional Task

- Explain the differences between 'tough', 'hard', 'strong' and 'stiff'. How would you use each of these words in connection with work on materials or forces?
- Give all the possible meanings of 'high', 'low' and 'soft' and explain how you would make their scientific meanings clear in work on sound.

Note: You will find the following useful – *A scheme of work for key stages 1 and 2: science* (1998):
www.standards.dfes.gov.uk/schemes/science/

5.2 HOW SHOULD CHILDREN COMMUNICATE THE PROCESSES AND RESULTS OF SCIENTIFIC INVESTIGATIONS?

www.standards.dfes.gov.uk/schemes/science/using2/experimental/

Children need to be taught how to make notes and keep records during science activities. Make explicit to them the main points of the activity and any essential observations. Ensure that they make use of their notes and records during group and class discussions. Teach them how information can be collected, recorded and presented in different forms, and how to choose the best way in which to record and present their own findings in particular investigations.

For more information, see Chapter 6: Section 9: Using ICT to support the teaching and learning of science

It is essential to teach children to communicate their findings orally as well as in writing. In presenting a written report, they need to be taught the different methods of presenting information for particular purposes and the conventions connected with it, such as the use of standard units and their abbreviations, conventional symbols and vocabulary.

Work on written communication, both on paper and electronically, makes use of, and develops, the children's knowledge, skills and understanding of English, mathematics and information and communication technology (ICT). The NC PoS for science indicates opportunities to make these links. In addition to oral and written presentation, children should learn how and when to use models, drawings, flow charts, diagrams and multimedia presentations.



Optional Task

Describe the **different** methods of presentation and communication which children could be taught to use in connection with each of the following science activities, and then say which would be the most appropriate:

Foundation stage

- Mixing ingredients for a cake, observing the changes which happen during mixing and baking;
- Visiting a farm and looking at animals and their young;
- Observing patterns in the environment such as tree bark, grating or grill covers, bricks and paving stones.

Key stage 1

- Testing materials to find out if they are waterproof;
- Finding out how near to an object they have to be in order to hear it – for example, comparing a quiet sound such as a dripping tap with a loud sound such as a bicycle buzzer or bell;
- Comparing two habitats, such as a well-used path and its borders and an uncultivated area of the school grounds: predicting, based on previous knowledge, which plants and animals will be found in each habitat, and then finding out.

Key stage 2

- Using a simple circuit to investigate materials to find out which ones conduct electricity;
- Finding out from books, CD-ROMs and websites about the heart, lungs and circulation;
- Planning and testing a method of separating a mixture of sand, salt and iron filings.

In your notes, highlight in different colours those that also develop the children's knowledge, skills and understanding of English, mathematics and ICT.

Chapter 6: Section 6: Science in the foundation stage and key stage 1

This section focuses on:

- 6.1 The scientific knowledge, skills and understanding children should learn during the foundation stage;
- 6.2 The scientific knowledge, skills and understanding children should learn during key stage 1 and how key stage 1 work builds on the foundation stage;
- 6.3 The ways in which work in science can be supported by, and contribute to, work in other subjects.

6.1 WHAT SCIENTIFIC KNOWLEDGE, SKILLS AND UNDERSTANDING SHOULD CHILDREN DEVELOP DURING THE FOUNDATION STAGE?



Reading

Curriculum guidance for the foundation stage (2000) or www.qca.org.uk/cal/foundation/, pp82–89 (the introduction to knowledge and understanding of the world and the part which covers science).

The foundation stage refers to children aged three to five (the end of the Reception Year), although not all children aged three to four attend a school or nursery. At the end of the Reception Year, some children might have had less than a year of formal education, while others might have had two years. Children will have entered Reception Year varying widely in experiences and abilities, and this variation will still be apparent by the time they enter key stage 1 (Years 1 and 2, for children aged five to seven). There are, however, common goals towards which teachers work. For science, these are set out in *Curriculum guidance for the foundation stage (2000)*, within the section on Knowledge and understanding of the world.

The *Curriculum guidance for the foundation stage* provides a structure within which teachers can plan learning experiences leading towards the early learning goals, which it breaks down into Stepping Stones at three broad levels, indicating progression from age three to the end of the foundation stage. It also gives guidance on what teachers and children need to do at each level in order to ensure progression.

6.2 WHAT SCIENTIFIC KNOWLEDGE, SKILLS AND UNDERSTANDING SHOULD CHILDREN DEVELOP DURING KEY STAGE 1?

When the children enter key stage 1 (in Year 1 at the age of five), they begin working towards the National Curriculum (NC) attainment targets (ATs) in science. The non-statutory scheme of work for science, produced by the QCA and Department for Education and Skills (DfES), shows how the content of the NC programme of study (PoS) for science can be split into units to be taught. It gives guidance as to how these units could be sequenced across each year in both key stage 1 and 2. It also shows how Sc1 (Scientific enquiry) can be taught in the context of the subject matter of the other sections of the PoS (Sc2, Sc3 and Sc4).

For more information, see Chapter 6: Section 1: The National Curriculum programme of study for science

The scheme of work indicates how each unit can build on previous learning and how it is connected with other science units and with other subjects, in particular information and communication technology (ICT), mathematics and English. Each unit gives an indication of the knowledge, skills and understanding which children can be expected to have developed by the end of it.

6.3 HOW CAN I LINK SCIENCE WITH WORK IN OTHER SUBJECTS?



Reading

Read the notes in the margins of the NC PoS for science at key stage 1 and note the suggested links with other subjects.

A scheme of work for key stages 1 and 2 science, Teacher's Guide pp4–22.

For more information, see Chapter 6: Section 9: Using ICT to support the teaching and learning of science

*QCA Primary Science & ICT schemes of work
<http://curriculum.becta.org.uk/docserver.php?docid=1424>*

*Primary Focus
<http://curriculum.becta.org.uk/docserver.php?docid=1421>*

It is not difficult to find natural links between subjects, for example:

- as children in the foundation stage talk about their observations of animals, they will develop personal, social and language skills;
- as they draw or describe the shape of a leaf, they develop their mathematical knowledge, skills and understanding;
- at key stage 1, children who are comparing the loudness of sounds will develop knowledge, skills and understanding of mathematics as they measure the greatest distances from which they can hear the sounds;
- their literacy skills will help them to make notes and to write a recount of an investigation and record the results in a chart.

The children's work in science can help them to develop the key skills which cross the boundaries of subjects and are useful throughout life.

They are:

- application of number (numeracy skills);
- effective communication (communication and literacy skills);
- use of computers, videos etc. (ICT skills);
- effective interaction with others (skills for working with others);
- meeting needs and solving problems (problem-solving skills).

The way in which you present science lessons affects the extent to which these skills are developed and used in order to further the children's knowledge and understanding of science, as shown in the examples in the Think About box on page 112.



Think About

Numeracy:	children testing paper towels to find the most absorbent could count the number of spoonfuls of water each paper towel soaks up and record their results on a picture graph or block graph;
Communication and literacy skills:	children who are investigating materials to see which show up best in the dark could make a poster or contribute to a class book about keeping safe when crossing roads in the dark;
ICT skills:	CD-ROM reference material that includes pictures and flow charts with captions could be used to find out about the life cycles of animals;
Working with others and problem-solving skills:	in groups, children could draw their ideas for the best ways in which to move a heavy object and then, having discussed safety implications with the teacher, work together to carry out their tests;
Problem-solving skills:	children could examine electrical circuits that do not work and find a way to make each one work – for example, by joining a wire to a battery or to a bulb, screwing a bulb into its holder or exchanging a spent battery for a new one.

The other cross-curricular skills that the children develop during science (and other subjects) are thinking skills, described in the NC as: information-processing skills, reasoning skills, enquiry skills, creative thinking skills and evaluation skills.



Optional Task

- Make a copy of any one of the key stage 1 units from *A scheme of work for key stages 1 and 2: science* (DfEE/QCA, 1998), www.standards.dfes.gov.uk/schemes/science/
- Highlight the activities that provide opportunities for developing key skills and thinking skills and using those skills to further children's learning in science.
- Indicate which key skills and thinking skills apply to which activities.

Sample medium-term planning for science

Topic Sorting and using materials	Year 1	Half term Autumn, 1st half
Time Wednesdays 1.15 to 2.15, Thursdays 9.15 to 10.00 (1 hour 45 minutes per week: total 8 hours 45 minutes)		
Aims Most children will be able to name some common materials; make observations of these and of common objects; communicate these using terms such as 'bendy', 'rough', 'hard'; suggest how to test an idea and say what the result of the test shows. Some children will not have made so much progress but will be able to make and communicate observations of common objects. Some children will have progressed further and will also suggest several reasons why a material may or may not be suitable for a particular purpose and predict the results of tests they are going to do.		
Week	Learning objectives and outcomes	Activities
1	Knowing and describing properties of materials. Recording observations of materials. Asking questions and exploring materials using appropriate senses. Making and communicating observations. Names of materials.	Handling and describing objects made from different materials. The children suggest which senses to use to find out about materials. 'Materials hunt' around the school, naming materials from which things are made.
2	Recognising that different everyday objects can be made from the same materials. The same objects can be made of different materials. Understanding how to group materials in different ways. Grouping materials by observation, and recording the groupings.	Display of wooden objects. Discussion of what wood feels like, where it comes from etc. Labelled displays of other materials: plastics, metals, glass. Using reference sources to find out about materials. Sorting collections of paper and cardboard: rough or smooth, shiny or dull. The children glue pieces of the different groups of paper and cardboard into labelled sets.
3	Grouping materials according to their properties. Explaining why materials are suitable for a purpose. Understanding that some materials are attracted to magnets and some are not; predicting which ones will be attracted and explaining why. Making observations, communicating findings and (with support) drawing conclusions, saying if their predictions were correct.	The children sort materials such as paper, plastic and wood according to their suitability for a given purpose, such as wrapping a present, making a scarf or making a window for a play house. Using magnets to play fishing games; finding out to which materials fridge magnets are attracted. Sorting materials according to whether or not they were attracted; labelling the sets.
4	Identifying the reasons for using materials for particular purposes – for example, glass for a window because it is transparent, wood for a door because it is strong. Suggesting ways of testing materials – for example, to find out which paper is the most difficult to tear.	The children draw and label pictures of themselves dressed for a wet day. The children decide which of a collection of different kinds of paper is best for wrapping a parcel.
5	Suggesting a test to find out which materials are waterproof, carrying out the test (with support) and communicating the results. Using results to group materials (eg. waterproof/not waterproof) and to record the grouping. Drawing conclusions.	The children test materials to find which are waterproof. They make an umbrella for a doll or teddy bear and test it.

This section focuses on:

- 7.1 The scientific knowledge, skills and understanding which children should learn in key stage 2 and how key stage 2 work in science builds on the knowledge, skills and understanding developed during key stage 1;
- 7.2 The ways in which work in science can be supported by, and contribute to, work in other subjects.

7.1 WHAT SCIENTIFIC KNOWLEDGE, SKILLS AND UNDERSTANDING SHOULD CHILDREN LEARN DURING KEY STAGE 2?

For more information, see Chapter 6: Section 1: The National Curriculum programme of study for science

In key stage 2 (Years 3 to 6), the children continue working towards the National Curriculum (NC) attainment targets (ATs) in science. The non-statutory scheme of work for science produced by QCA and the Department for Education and Skills (DfES) shows how the content of the NC programme of study (PoS) for science can be split into units to be taught during each year of key stages 1 and 2. It also gives guidance as to how these units could be sequenced across each year in each key stage. It shows how Sc1 (Scientific enquiry) can be taught in the context of the subject matter of the other sections of the PoS (Sc2, Sc3 and Sc4). This scheme of work indicates how each unit can build on previous learning and how it is connected with other science units and with other subjects – in particular, information and communication technology (ICT), mathematics and English. Each unit gives an indication as to the knowledge, skills and understanding children should have developed by the end of it.

Your school's scheme of work will indicate the area of content to be taught and the knowledge, skills and understanding to be developed during any particular half-term. You will need to plan teaching and learning activities to cover that content and achieve those aims. Your planning should have a sequence of steps to show the order in which ideas, concepts and skills will be introduced.



Optional Task

Read the sample half-termly planning sheet on page 116 and think about how you would plan the science work for a key stage 2 class for half a term (five weeks).

Note: You will need to refer to the NC science PoS for key stage 2 and the science ATs.

7.2 HOW CAN I LINK WORK IN SCIENCE WITH WORK IN OTHER SUBJECTS?



Reading

The notes in the margins of the NC PoS and the suggested links with other subjects.

The National Curriculum (2000), pp20–22.

A scheme of work for key stages 1 and 2: science, Teacher's Guide (1998) pp4–22.

www.standards.dfes.gov.uk/schemes/science/using2/links/

The children's work in science can help them to develop the key skills that cross the boundaries of subjects and are useful throughout life. They are:

- application of number (numeracy skills);
- effective communication (communication and literacy skills);
- use of computers, videos etc. (ICT skills);
- effective interaction with others (skills in working with others);
- meeting needs and solving problems (problem-solving skills).

The way in which teachers present science lessons affects the extent to which these skills are developed and used, in order to further the children's knowledge and understanding of science, as shown in the following examples:



Think About

- **Numeracy:** children learning about keeping healthy could count their pulse beats for 30 seconds (a partner times them with a stopwatch) before and after exercise, record the results on a database and work out class average pulse rates at rest and after exercise.
- **Communication and literacy and ICT skills:** children who are finding out about gases could scan printed and electronic texts to find which of them will be useful, make notes of their titles and where to find them and then return to them and skim them for the information they need. They could use abbreviations and symbols in their note-making and organise their notes under headings, such as 'Gases in foods', 'Gases for fuel' and 'Dangerous gases'. They could present their findings in the form of a booklet or poster.
- **ICT and problem-solving skills:** sensors could be used to record levels of noise in different places around the school to enable the children to identify the quietest and noisiest places. They could plan a fair test to find the best way to muffle the sound of an alarm clock, using sensors to measure the sound levels.
- **Skills in working with others:** when planning the best way in which to test the load-bearing strength of beams made from paper folded and shaped in different ways, the children could begin by brainstorming as a group and then selecting the best method. They could share the tasks in the investigation.
- **Problem-solving skills:** in work on magnetism, the children could look for quick ways in which to separate brass screws from steel screws, steel paper clips from brass drawing pins, aluminium cans from steel cans and iron nails from copper nails.



Optional Task

Make a copy of any key stage 2 unit from *A scheme of work for key stages 1 and 2: science (1998)*. Highlight the activities that provide opportunities for developing key skills and thinking skills and for using those skills to further children's learning in science. Indicate which key skills and thinking skills apply to which activities.

The other cross-curricular skills that the children develop during science (and other subjects) are thinking skills, described in the NC as information-processing skills, reasoning skills, enquiry skills, creative thinking skills and evaluation skills.

Sample medium-term planning for science

Topic	Sorting and using materials	Year	4	Half term	Spring, 1st half
Time	Wednesdays 1.15 to 2.15, Thursdays 9.15 to 10.15 (2 hours per week: total 10 hours)				
Aims	<p>Most children will recognise that temperature is a measure of how hot or cold objects are; identify some materials that are good thermal insulators and some everyday uses of these; recognise that the same materials keep cold objects cold as keep warm objects warm; use thermometers to measure temperatures; suggest how to investigate a question; construct tables for their results and offer simple explanations for results.</p> <p>Some children will not have made so much progress but will recognise that temperature is a measure of how hot or cold objects are; identify some everyday uses of thermal insulators; use thermometers to measure temperature and present results in tables prepared for them.</p> <p>Some children will have progressed further and will also recognise that objects cool or warm to the temperature of their surroundings when they are left, and recognise that metals are both good thermal and good electrical conductors.</p>				
Week	Learning objectives and outcomes	Activities			
1	Understand that the sense of touch is not an accurate way of judging temperature. Learn how to use a thermometer.	Children feel icy, warm and room temperature water, then compare the feel of warm water using one hand which has been immersed in cold water and the other in very warm water. They: <ul style="list-style-type: none"> • decide how useful the sense of touch is and how to make a better judgement; • read the scale on a thermometer, identifying boiling and freezing point; • take the temperature of ice (and, as a teacher demonstration, boiling water). 			
2	Use a thermometer to make measurements of temperature. Know that temperature is a measure of how hot or cold things are and that hot things cool down and cold things warm up to the temperature of the surroundings.	Children learn to use a thermometer and then take the temperature of cold, tepid, warm and hot water, repeat after an hour, record the results and compare them with the first reading. They suggest what has happened.			
3	Use software and sensors to collect, store and retrieve information and to explain trends and patterns in results. Turn an idea about how to keep things cold into a form that can be investigated. Decide what evidence to collect. Make a table and record results on it. Draw conclusions from results.	Children draw a plan of the classroom showing areas they think are hot or cold, give explanations and guess the room temperature. Use a sensor or thermometer to record the temperature in those places over 24 hours. They suggest and test ways to keep things cool, consider what to record and make a table for their results, and write about, and draw, what they did.			
4	Turn an idea about how to keep things warm into a form that can be investigated. Plan a fair test, deciding what to change, what to keep the same and what to measure. Make careful measurements of temperature at regular time intervals. Record results on a table and draw conclusions. Learn which materials are good thermal insulators.	Children consider materials that keep them warm in winter and plan a fair test to find out which materials will keep something warm the longest. Consider which materials kept ice cubes from melting and liquids from cooling, and how vacuum flasks work. Consider that good thermal insulators keep cold things cold and warm things warm.			
5	Learn that metals are good thermal conductors but that wood and plastics are not, and that good electrical conductors are often good thermal conductors. Recognise a range of uses for thermal conductors and insulators.	Children put metal, plastic and wooden spoons into a container of hot water and feel how warm the handles are after five to ten minutes. They suggest why saucepans often have wooden or plastic handles and record their explanations by drawing and writing. Children prepare a class presentation about keeping things warm or keeping things cool.			

Chapter 6: Section 8: Planning to meet the needs of all children

This section focuses on:

- 8.1 What is a positive approach?
- 8.2 How to cater for higher-attaining children;
- 8.3 How to differentiate during whole-class teaching;
- 8.4 How to cater for children with Special Educational Needs (SEN) during whole-class sessions;
- 8.5 How to cater for children for whom English is an Additional Language (EAL) during whole-class sessions.

8.1 WHAT IS A POSITIVE APPROACH?

www.nc.uk.net/inclusion.html

For more information about Inclusion, SEN and Gifted and Talented, see 'Getting Started' in this series

A positive approach regards the differing abilities, experiences and needs that children have as a challenge to be met, rather than as a difficulty or hindrance. Schools and teachers are required to provide equality of opportunity for all children – boys and girls, children with SEN, children with disabilities, children from different social and cultural backgrounds, children from different ethnic groups (including travellers, refugees and asylum seekers), and those from diverse linguistic backgrounds. The schools in which you teach will have policies for SEN, EAL and equal opportunities/inclusion. Many will also have teachers with special responsibility in these areas.

Every child is entitled to the opportunity to experience success in learning and to achieve as high a standard as possible. For the teacher, this might mean basing teaching and learning activities for some children on the programme of study (PoS) for earlier or later key stages.

As with any subject, you should know, from results of assessments, the range of attainment of the children you will teach. It is essential to talk to the school's Special Educational Needs Co-ordinator (SENCO) about any children who have special needs, to find out about Individual Education Plans (IEPs) and any support or resources that are available.

Differentiation is essential in teaching any class, even if there are no children with SEN or EAL, since the range of the children's attainment could extend across several National Curriculum (NC) levels. It is usually sufficient to plan group or independent work at three different levels.

For more information, see Chapter 6: Section 10: Planning and organising science lessons

8.2 HOW CAN I PROVIDE CHALLENGING ACTIVITIES FOR VERY ABLE CHILDREN?

www.nc.uk.net/gt/

For more information, see Chapter 6: Section 1: The National Curriculum programme of study for science

Although children are expected to reach certain minimum levels at the end of key stages 1 and 2, this does not mean that very able children should languish at levels below their potential. The main challenge to you lies not in the provision of suitable activities for independent work, but in including those children in whole-class teaching and holding their interest, without allowing them to dominate discussions.



Optional Task

Plan three independent or group activities for a class you have taught.

You will need to refer to the relevant section of the NC science PoS and attainment targets and the section headed *Inclusion: providing effective learning opportunities for all pupils* (pages 30–37), and the relevant units of *A scheme of work for key stages 1 and 2: science*. You will also need to refer to the *SEN Code of Practice* and DfES/QCA guidelines on SEN, EAL and gifted children at www.dfes.gov.uk/sen. You could also search the A–Z index.

Write on the appropriate parts of the chart on page 121, which is also designed to be used for the other Optional Tasks on this page.

8.3 HOW CAN I DIFFERENTIATE DURING WHOLE-CLASS TEACHING?

For more information, see Chapter 6: Section 10: Planning and organising science lessons

Whole-class teaching should include differentiation to cater for the needs of all the children. The help of other adults, including support teachers, classroom assistants and parents, can be built into your planning to enhance the participation of children with SEN or EAL. A science activity can be introduced to the whole class using a common starting point which evokes the children's interest and gives relevance to what they learn – for example, to introduce work on parts of the body to Year 1, you can play 'Simon says'. Words that some children do not know can be learned from the other children; you can ensure that these children learn by asking them to repeat either the action or the instruction for the class.

DfES/QCA produce *Planning, teaching and assessing the curriculum for pupils with learning difficulties* in a number of subject areas including science. It shows how the DfES/QCA schemes of work can be adapted for pupils with learning difficulties and includes opportunities and activities for key stages 1 and 2. It can be downloaded from the website or purchased in booklet form.



Optional Task

Add an introductory session to the chart on page 113 in which you make the tasks relevant to the children, revise previous work and introduce new ideas or vocabulary. Add a plenary session during which the children can report back on their findings and in which you can reinforce new vocabulary and ideas and help the children to interpret, or draw conclusions from, their findings. Make a note of the ways in which you can differentiate for children of different levels of attainment.

8.4 SURELY WHOLE-CLASS TEACHING AND EVEN GROUP WORK WILL BE ABOVE THE LEVEL OF CHILDREN WITH SEN?

www.nc.uk.net/ld/Sc_respond.html

Some whole-class teaching will be above the level of children with SEN. Questions at the level at which these children are working can form useful revision points for some of the other children. These questions should be based on targets set in the children's IAPs. To develop their confidence and self-esteem, you should ensure that some of the questions are based on targets the children have already reached. Their work should be discussed with the school's SENCO.



Optional Task

List the main types of special needs that might affect children.

Highlight any parts of the whole-class or group work that need to be adapted so that those children can take part as fully as possible in, and benefit from, the lesson.

Make notes about the adaptations you can make.

8.5 HOW CAN CHILDREN FOR WHOM ENGLISH IS AN ADDITIONAL LANGUAGE TAKE PART IN WHOLE-CLASS WORK?



Reading

Access technology: making the right choice (Rahamim, 2000) – based on *Access technology: making the right choice* (Day, 1995) on the Becta website:

www.becta.org.uk/inclusion/sen/technology/access_technology/index.html

Some children need special help to develop their knowledge and understanding of English, and may still be learning to speak English. They should be encouraged to talk, describe and hypothesise in English, and in their home language if bilingual assistance is available. You can give a high status to the children's home and community cultures and languages in this way. You can also do this by encouraging the use of those languages and providing dual-language textbooks and displays (with the help of teaching assistants if you do not speak the languages yourself).

Some schools have help from teaching assistants who can act as interpreters during whole-class work, prepare dual-language materials or explain and discuss the tasks set by the teacher to help the children to take part in group and independent work. However, this support is usually available for limited periods only and schools are likely to direct it to the Literacy Hour or daily maths lesson. You should read the school's policy on EAL and find out from the EAL co-ordinator about any support and resources that can be provided.



Optional Task (Use the lesson plan on page 121)

Plan, and describe in detail, differentiated group or independent activities for either lesson 1 or lesson 2.

Lesson 1: Year 2: Forces and movement, from A scheme of work for key stages 1 and 2: science, Unit 2E

Using a collection of pictures, a video clip or a collection of toys to illustrate ways of moving, review learning about movement by asking the children to suggest as many words as possible to describe the movement in the pictures/video/toys.

Objectives	Possible activities	Outcomes
<p>The children should learn:</p> <ul style="list-style-type: none"> that pushes or pulls can make things speed up or change direction. 	<p>Present the children with a collection of toy cars and ask them how to make them move faster or slower, or change direction. In physical education, ask children to throw bean bags or hit soft balls to one another and to suggest how to make them move faster or slower, or change direction.</p>	<p>The children describe how to: make things speed up or change direction, eg. by saying 'When I push the car hard it goes faster' or 'When I hit the ball it went off to the side'.</p>

Lesson 2: Year 4: Forces and movement, from A scheme of work for key stages 1 and 2: science, Unit 4E Friction

Review the children's learning by asking questions to elicit ideas about forces that they have already encountered, eg:

- pushes and pulls such as attraction and repulsion between magnet or stretched and compressed springs;
- forces acting on objects in particular directions;
- effects of forces in relation to their size.

Reinforce this by letting the children explore magnets and springs, and asking them to identify the directions in which the forces are acting.

Objectives	Possible activities	Outcomes
<p>The children should learn:</p> <ul style="list-style-type: none"> to use a force meter carefully to measure forces; that 'newton' is the unit of force; that there is a force between an object and a surface that might prevent the object moving. 	<p>Show the children force meters; point out the spring inside; ask how they work.</p> <ul style="list-style-type: none"> Help the children to practise reading the force meter (eg. when another child pulls on it, pulling open a drawer or dragging an object across the floor). Ask if it would be more or less difficult to get an object moving on a smooth or rough surface. Ask the children how they could find the answer and, if appropriate, demonstrate using a force meter attached to an object, eg. a weighted margarine tub or shoe. 	<p>The children use a force meter to:</p> <ul style="list-style-type: none"> measure forces, reading the scale accurately; explain that a bigger reading on the force meter shows that it is more difficult to get an object moving than does a smaller reading.

Lesson	Unit	Year	Topic title
Introduction (whole class)			
Learning outcomes	Resources		Differentiated questions and discussion points
Content			
Differentiated group and independent tasks			
Lower-achieving children	Children at the expected level of attainment		Higher-achieving children
Plenary session or conclusion			
Content			Differentiated questions and discussion points

Use this as a checklist for information you need about any new class that you are going to teach.

Planning for inclusion in science

Class	Year	Usual teacher's name (if applicable)	
Range of ability in science		Levels	
Names of SENCO, support teachers, classroom assistants and voluntary assistants. When they are available.			
Children with SEN		Names, stages of special need (see the <i>SEN Code of Practice</i>)	
EAL children		Names and details	
Higher-attaining children		Names and details	
Documents that you should obtain from the school (✓)			
Science policy		Long-term planning for science, including time allocation	Equal opportunities/inclusion policy
Resource and book lists for science, SEN, EAL		SEN policy	EAL policy

Chapter 6: Section 9: Using ICT to support the teaching and learning of science

This section focuses on:

- 9.1 The ways in which information and communication technology (ICT) can support work in science in the foundation stage and key stages 1 and 2;
- 9.2 Advantages of using ICT in science;
- 9.3 The support available to help teachers use ICT in science lessons and the types of software that can support the teaching and learning of science.

9.1 WHY SHOULD I INCLUDE ICT IN SCIENCE LESSONS?



Reading

Notes in the margins of the NC PoS for science ('ICT opportunity')

Curriculum guidance for the foundation stage (2000)

www.qca.org.uk/ca, pp92–93 (ICT)

NC PoS for ICT.

For more information, see 'Filling the Gaps' in this series

The National Curriculum (NC) stresses the need to plan for ICT across the whole curriculum. The school's long-term curriculum planning for ICT and other subjects will indicate how the ICT programme of study (PoS) is covered each year.

You should obtain the school's long-term planning, its policy for ICT and a list of ICT resources for science. Your medium-term planning should indicate how you will incorporate ICT in your science lessons, noting the relevant part of the ICT PoS and scheme of work, and the type of software/hardware which will be used. If you are not familiar with any of the school's ICT resources, you should ask the ICT co-ordinator for help.

9.2 WHAT ARE THE ADVANTAGES OF USING ICT IN SCIENCE?

The use of ICT in science can enhance teaching and learning in many ways. Go to <http://curriculum.becta.org.uk/docserver.php?docid=1425> and click on one of the following links for details of how computers can support pupils' learning:

- Set for success;
- Starting science;
- Collecting data in science;
- Using data in science;
- Communicating science.

For details of how ICT can support the QCA schemes of work for science, go to <http://curriculum.becta.org.uk/docserver.php?docid=1424>

Each of the following units includes background notes, activity sheets, support files and, where appropriate, links to other websites:

- Ourselves;
- Helping plants to grow;
- Materials;
- Keeping cool;
- Earth moon and sun;
- Health and growing;
- Growing plants;
- Habitats;
- Keeping healthy.

9.3 CAN I RECOGNISE OPPORTUNITIES FOR INCLUDING ICT IN SCIENCE LESSONS?

<http://vtc.ngfl.gov.uk/docserver.php?temid=77>

<http://vtc.ngfl.gov.uk/docserver.php?temid=208>

<http://curriculum.becta.org.uk/docserver.php?docid=1421>



Reading

Go to

<http://curriculum.becta.org.uk/docserver.php?docid=1425>

for details of how computers can support pupils' learning within science.

To find out how ICT can support the QCA schemes of work for science go to

<http://curriculum.becta.org.uk/docserver.php?docid=1424>.

A good starting point is the Becta (British Educational Communications and Technology Agency) website. This site provides up-to-date information about resources as well as providing ideas for use in the classroom. For example, it gives details of the software and hardware that could be used:

- **starting points to introduce a topic or raise a question:** CD-ROMs, simulation programs, DVDs, websites;
- **scientific investigation:** branching keys, databases and spreadsheets;
- **measuring, and collecting data:** sensors, timers and cassette recorders;
- **organising and displaying data from which children can make predictions, identify patterns and trends and draw conclusions:** spreadsheets, databases and graph-drawing programs;
- **communicating results and information:** word-processing, cassette recorders, digital cameras, graphics (including photographs taken by the children) and desktop-publishing programs, the internet for creating and using class or school websites, and e-mail for sending and receiving messages both within the school and beyond it.



Optional Task

- Enlarge to A3 the half-termly planners for science which you completed for either Section 6: Science in the foundation stage and key stage 1 or Section 7: Science in key stage 2, and add any ideas you can think of for including ICT.
- To begin with, include all your ideas – there will probably be far too many to use during the half-term. Then highlight those which you think are the most achievable/useful/appropriate/relevant.
- Record the parts of the NC PoS for ICT that will be taught during the work in science.

Note: You will need to refer to the NC PoS for ICT, the NC PoS for Science and, if you have chosen the foundation stage, 'Knowledge and Understanding of the World' in the *Curriculum guidance for the foundation stage (2000)*

The following resources will be helpful:

DfES/QCA primary science and primary ICT schemes of work:

Becta website: www.becta.org.uk/

Virtual Teachers' Centre: <http://vtc.ngfl.gov.uk/>

ICT for teachers: www.icteachers.co.uk



Optional Task

Return to the chart you completed for the Optional Tasks on page 121 of Section 8: Planning to meet the needs of all children. Make notes on opportunities for including ICT in the lesson. Make a note of all your ideas; you would not use all of them in one lesson, but this will help you to become aware of the resources which are available and the ways in which they can be used.

Note: A good starting point is <http://vtc.ngfl.gov.uk/>. Click on one of the following: • Software Database • Learning Resources Index • Discussion Groups or • Teacher Resources Exchange. On this website you can find out how other teachers have used ICT in their lessons.

Chapter 6: Section 10: Planning and organising science lessons

This section focuses on:

10.1 The essential details that should be included in lesson plans.

10.1 WHAT SHOULD BE INCLUDED IN A SCIENCE LESSON PLAN?

A lesson plan should include:

- details of the class;
- teacher;
- date;
- topic;
- the section and strand of the National Curriculum (NC) science programme of study (PoS) to be taught and to which levels;
- the objectives or targets of the lesson in terms of what the children will learn and be able to do: making clear the targets to be achieved by the end of the lesson helps to make the lesson purposeful and helps the children to take appropriate responsibility for their learning;
- details such as discussion points and key questions to be used during whole-class and group teaching and planning for differentiation: specific questions and discussion points for certain children and differentiated practical tasks or other group work;
- any opportunities that will arise for developing literacy and numeracy skills and for using ICT (the relevant section and strand of the ICT PoS should be noted);
- the organisation of the lesson – for example, timing, how other adults are to be deployed, and how the children will be grouped;
- a list of resources such as books, worksheets, ICT equipment and scientific equipment and other materials such as cardboard, stones, water and cotton wool;
- risk management is essential in science lessons and the lesson plan should include brief notes on any warnings to be discussed with adult helpers or the children.

*For more information, see
Chapter 6: Section 11: Managing
risks*

Having clear targets enables the teacher to evaluate the lesson by judging the children's attainment against these targets. In addition to evaluating the lesson in terms of children's learning, you can also evaluate it in terms of teaching methods (including organisation) and the children's response (How attentive and interested were they during whole-class teaching? How carefully did they work on independent tasks and what was their level of perseverance?)

This section focuses on:

- 11.1 The potential health and safety risks of any science lesson you teach;
- 11.2 How to teach children to take appropriate responsibility for their own health and safety and that of others;
- 11.3 What to do if there is an accident.

11.1 DO I KNOW ALL THE POTENTIAL HEALTH AND SAFETY RISKS OF SCIENCE LESSONS?

www.dfes.gov.uk/a-z/HEALTH%5FAND%5FSAFETY.html



Reading

Be Safe! (2001)

Safety in School Science for Primary Schools (1994)

www.ase.org.uk/safety/

The consideration of safety should not make you afraid of practical science activities. As noted in the introduction to *Be Safe!* (Association for Science Education), there are very few reported accidents in primary schools and almost none of them arise during science lessons. Your science lessons will be safe if you prepare them well and anticipate risks. You will find *A scheme of work for key stages 1 and 2: science* (1998) helpful in this respect – each unit includes safety points, which are easily recognised by the warning triangle logo.

Many potential risks can be avoided by common-sense precautions, but to recognise and avert other risks you will find specialist guidelines useful. The guidelines in *Be Safe!* have been adopted by the Department for Education and Skills (DfES) and OFSTED.



Optional Task

Answer the following questions on safety. Check your responses in *Be Safe!*

- Which of the following, if any, are suitable heat sources for melting chocolate:
 - a) a night-light standing in a tray of sand
 - b) a spirit burner on a heat-proof mat
 - c) a mains electric ring or cooker top
 - d) a picnic stove?
- Which of the following substances are safe to use with children:
 - a) clay
 - b) borax
 - c) glycerine
 - d) sterilising solutions like Milton
 - e) dishwasher detergent
 - f) weedkillers?
- Is it safe to test a hot-air balloon indoors? If so, what heat source should you use?
- Name any types or voltages of battery that are not safe for school use.
- Which of the following micro-organisms, if any, can be studied safely in the classroom, and what precautions should be taken:
 - a) baker's yeast
 - b) mould on bread
 - c) mould on fruit?
- Which of the following plants are poisonous, and can you recognise them:
 - a) dandelion
 - b) henbane
 - c) cuckoo pint
 - d) laburnum
 - e) Swiss cheese plant?
- What risks should you consider during the following activities:
 - a) counting pulse beats after vigorous exercise
 - b) smelling, then tasting, different foods?
- How should batteries be stored, and why?

11.2 TO WHAT EXTENT CAN CHILDREN BE EXPECTED TO TAKE RESPONSIBILITY FOR THEIR OWN SAFETY AND THAT OF OTHERS?



Reading

Read *Be Safe!* (2001) and note the ways in which risks can be minimised by safe storage of equipment and materials.

Teachers, parents and other adults naturally want to ensure that children are safe but, if everything is done for them, children never have the opportunity to develop good safety habits for themselves.



Think About

You can help the children you teach to take appropriate responsibility for health and safety by explaining dangers and encouraging them to act safely. For example, very young children can be taught:

- to sweep up sand and mop up water (on which people might slip);
- not to leave things on the floor where people can trip over them;
- always to wash their hands before handling food or after handling animals.

Older children can formulate their own safety rules. For example:

- if substances are to be heated in the classroom, the children can identify the dangers;
- they can say how to avoid dangers, with the teacher drawing attention to anything they omit;
- health and safety issues can provide useful opportunities for personal, social and health education.

You can teach safety by example. In some lessons, you can build in time for teaching the children about safety or make explicit the reasons why you are taking certain precautions. For instance, you can:

- point out the reason for covering table tops before a food-tasting session;
- explain why batteries and not mains electricity are used in science lessons;
- talk about why you have directed the mouth of a test-tube containing a substance to be heated away from yourself and them.

Risks can be minimised by careful organisation and storage of equipment and materials. For example:

- tools should be returned to the tool-board or toolbox after use;
- equipment to be used with food should be stored separately from other items and labelled 'food only';

11.3 DO I KNOW WHAT TO DO IF THERE IS AN ACCIDENT?



Checklist

When you begin teaching in any school, you should ensure that you are provided with copies of:

1. The school's health and safety or risk-management policy;
2. Local authority health and safety guidelines;
3. The school's first-aid guidelines (if they are not included in 1);
4. The school's accident procedure (if it is not included in 1 or 3).

You need to read the school's health and safety policy and first-aid guidelines before you begin teaching. These will indicate what to do in particular circumstances. The children themselves need to be taught what to do and who to inform when an accident happens – for example, what to do if glass is broken.

Schools are required to keep an accident book, in which any injuries are recorded. This book will include guidelines on the kinds of injuries that should be recorded.

Useful reading and resources

- ASE (2001 3rd edition) *Be Safe!* Hatfield: Association for Science Education. (Available from ASE, College Lane, Hatfield, Herts, AL10 9AA)
- DfEE (1998) *Baseline assessment of pupils starting primary school*, Circular 6/98. London: DfEE.
- DfEE (1998) *Standards for the Award of Qualified Teacher Status*, Circular 4/98. London: DfEE.
- DfEE (2000) *Draft revised SEN Code of Practice*. London: DfEE.
- DfEE (2000) *NLS Working with teaching assistants: a good practice guide*. London: DfEE.
- DfEE/QCA (1998) *A scheme of work for key stages 1 and 2: Information and communications technology*. London: DfEE/QCA.
- DfEE/QCA (1998) *A scheme of work for key stages 1 and 2: science*. London: DfEE/QCA.
- DfEE/QCA (1999) *National Curriculum attainment targets for science for key stages 1 and 2*. London: DfEE/QCA.
- DfEE/QCA (1999) *National Curriculum Handbook for primary teachers in England: key stages 1 and 2*. London: DfEE/QCA.
- DfEE/QCA (2000) *Curriculum guidance for the foundation stage*. London: DfEE/QCA.
- DfEE/QCA (2000) *The National Curriculum, (Inclusion: providing effective learning opportunities for all pupils)* pp30–37. London: DfEE/QCA.
- DfES/TTA (2002) *Qualifying to teach: Professional Standards for Qualified Teacher Status and Requirements for Initial Teaching Training*. London: DfES.
- Johnsey, R et al (2002) *Primary science knowledge and understanding*. Exeter: Learning Matters
- National Curriculum Council (1992) Knowledge and understanding of Science*. London: NCC.
- Newton, L (2000) *Meeting the standards in primary science: a guide to the ITT NC*. London: Routledge Falmer.
- OFSTED (1996) *Inspecting safety in science: a guide for OFSTED Inspectors in primary schools*. London: OFSTED.
- OFSTED (1999) *Pupils with specific learning difficulties in mainstream schools*. London: OFSTED.
- OFSTED (1999) *Raising the attainment of ethnic minority pupils*. London: OFSTED.
- OFSTED (2000) *Evaluating educational inclusion*. London: OFSTED.
- QCA (1998) *Maintaining breadth and balance at key stages 1 and 2*. London: QCA.
- QCA (2000) *A language in common: assessing English as an Additional Language*. London: QCA.
- QCA (2001) *Curriculum guidelines for pupils achieving significantly below age-related expectations*. London: QCA.
- QCA (2001) *Guidance on meeting the requirements of gifted and talented pupils*. London: QCA.
- QCA (annually), *Arrangements for Statutory Testing*. London: QCA.
- Local authority health and safety guidelines and the health and safety policy of any school in which you teach.
- Rahamim, L (2000) *Access technology: making the right choice* (based on *Access Technology: making the right choice*; Day, J, NCET, 1995) Becta.

Useful websites

Please note that the websites referred to throughout the chapter have not been reproduced here. At the time of publication, the DfES is in the process of changing the stem of some of its website addresses from *www.dfee* to *www.dfes*. Should you be unsuccessful in making a connection with the address we have provided here, try typing in the alternative stem followed by the rest of the address. You may need Adobe Acrobat Reader™ to view/download any documents available on these websites.

www.qca.org.uk/cal

www.becta.org.uk/technology/infosheets/index.html#sn

www.besanet.org.uk/

www.dfes.gov.uk/sen/

www.dfes.gov.uk/sen/viewDocument.cfm?dID=260

www.nc.uk.net/gt/

www.dfes.gov.uk/sen/documents/GLOSSARY_of_SEN_Terms.htm

http://212.187.191.20/prog_study.html

www.ase.org.uk/safety/ofsted2.html

www.nasen.org.uk/

<http://inclusion.ngfl.gov.uk/>

www.ofsted.gov.uk/public/index.htm

www.nc.uk.net/ld

www.ase.org.uk/safety/

www.qca.org.uk/cal/subjects/ict/

www.standards.dfee.gov.uk/performance/

<http://contribute.ngfl.gov.uk>

Arrangements for statutory testing, curriculum and assessment.

British Educational Communications and Technology Agency (Becta) resources to support the teaching of children with SEN, and information sheets about specific disabilities and how ICT can provide access to the curriculum.

British Educational Suppliers Association (BESA).

DfES Centre for Special Educational Needs.

DfES SEN Code of Practice.

Gifted and Talented Children Policy.

Glossary of SEN terms

How the National Curriculum works.

Inspecting safety in science.

National Association for Special Educational Needs.

National Grid for Learning: Inclusion.

OFSTED publications.

QCA Learning Difficulties.

Safety articles.

Scheme of work for key stages 1 and 2 – ICT.

Target setting.

Teacher Resource Exchange System.