

National curriculum tests

Key stage 2

Science sampling test framework

National curriculum tests from 2016

For test developers



Standards
& Testing
Agency

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2016 key stage 2 science sampling test framework:
national curriculum tests from 2016

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1. Overview

This test framework is based on the national curriculum programme of study (2014) for science, introduced for teaching in schools from September 2014 and first assessed in the summer term 2016. The framework specifies the purpose, format, content and cognitive domains of the key stage 2 science sampling tests; it is not designed to be used to guide teaching and learning or to inform statutory teacher assessment.

These tests are used to monitor national standards using pupil-level matrix sampling. This approach uses a largely common set of questions which are securely administered to compare standards over a number of test cycles.

This document has been produced to aid the test development process.

1.1 Purposes of statutory assessment

The main purpose of sample statutory assessment is to estimate national performance in relation to areas of the national curriculum (2014) in science, based on the performance of a sample of pupils.

The main use of the data is to inform schools and other stakeholders about trends in pupils' performance in science.

No information is kept or reported on any school's or pupil's performance on the science sampling assessment.

1.2 Pupil-level matrix sampling

Pupil-level matrix sampling will use a number of different test instruments to assess the science national curriculum (2014). The sampling tests will be securely administered by external assessors to a representative sample of pupils. The exact size of each sample will be determined by the data and reporting requirements.

Matrix sampling, requiring the use of several test instruments, will ensure that there is greater national curriculum coverage in each assessment cycle than if there were a single instrument of assessment. In 2016, pupil-level matrix sampling will assess the 2014 curriculum using paper-based tests.

The pupil-level matrix sampling approach also has scope for monitoring national performance against international benchmarks such as Trends in International Maths and Science Survey (TIMSS). The International Association for the Evaluation of Educational Achievement (IEA) has agreed that a sample of the questions used in the TIMSS survey can be used, which will allow international assessment results to be linked with UK national sample testing.

2. What is a test framework?

The purpose of the test framework is to provide the documentation to guide the development of the tests. The framework is written primarily for those who write test materials and to guide subsequent development and test construction. It is being made available to a wider audience for reasons of openness and transparency.

Some elements of the statutory national curriculum are not possible to assess using the current form of testing; they will need to be assessed by teachers as part of their statutory assessment of the complete national curriculum.

The test framework includes those parts of the programme of study as outlined in the national curriculum (2014) that will be covered in the test (the content domain). The cognitive processes associated with measurement of science are also detailed in the cognitive domain.

The test framework also includes a test specification from which valid, reliable and comparable tests will be constructed each year. This includes specifics about test format, question types, response types, marking and a clear test-level reporting strategy.

By providing all of this information in a single document, the test framework answers questions about what the test will cover, and how, in a clear and concise manner. The framework does not provide information on how teachers should teach the national curriculum.

The test development process used by the Standards and Testing Agency (STA) embeds within it the generation of validity and reliability evidence through expert review and trialling. Given the nature of evidence collected, it is not anticipated that any additional studies will be required to demonstrate that the tests are fit for purpose. The test framework does not provide detail of the validity and reliability of individual tests; this will be provided in the test handbook, which will be published on the DfE's website following the administration of the test.

The test framework should be used in conjunction with the national curriculum (2014) and the annual 'Assessment and reporting arrangements' (ARA) document.

3. Nature of the test

The key stage 2 science sampling test forms part of the statutory assessment arrangements for pupils at the end of key stage 2.

The test is based on the relevant sections of the national curriculum statutory programme of study (2014) for science at key stage 2.

The test will cover the aspects of the curriculum that lend themselves to paper-based, externally marked testing.

The tests will be securely administered in the selected schools by external administrators. Schools will not have access to the test papers after the administration. A set of questions will be made public after each assessment cycle, which schools can use for teaching purposes.

3.1 Population to be assessed

All pupils who are registered at maintained schools, special schools, or academies (including free schools) in England and are at the end of key stage 2 will be eligible to be selected to take part in the key stage 2 science sampling test.

Some pupils are exempt from the tests. Further details will be made available to participating schools.

3.2 Test format

The key stage 2 science sampling test comprises three components, which will be presented to pupils as three separate papers. The test is administered on paper and the total testing time is 75 minutes. There are five different versions for each component and each pupil will be assigned one version of each component. The order of the components will vary for each pupil.

Table 1: Format of the test for each pupil

Component	Description	Number of papers	Number of marks	Approximate timing of component
Test paper b	questions in a biology context	1 (from 5 versions)	22	25 minutes
Test paper c	questions in a chemistry context	1 (from 5 versions)	22	25 minutes
Test paper p	questions in a physics context	1 (from 5 versions)	22	25 minutes
	Total	3	66	75 minutes

4. Content domain

The content domain sets out the relevant elements from the national curriculum programme of study (2014) for science at key stage 2 that are assessed in the science sampling tests. It is intended that all assessable elements of the content domain will be assessed in each administration.

The content domain for biology, chemistry and physics identifies strands of the programme of study that can only be partially assessed in the sampling tests due to the practical nature of those strands. These are marked with an asterisk (*) in Tables 2, 3, 4 and 5 and summarised and explained in Table 6.

To facilitate test development, each strand of the new programme of study has been assigned to one of the three core areas of science: biology, chemistry and physics. The suite of assessments for any one year in which matrix sampling occurs will cover these three core areas in approximately equal measure, even though there are slightly fewer strands for chemistry than there are for biology or physics. In the tables that follow, all the strands from the new programme of study for biology, chemistry and physics are given, as it is possible to assess all areas to some extent with paper-based tests. The 'Working scientifically' content has been described separately but will be assessed within the context of one of the three core areas of biology, chemistry or physics and will therefore always be classified under both areas.

4.1 Content domain for biology

Table 2: Content domain for biology

Topic	Strand from programme of study	Year group
Plants (B)	B3a identify and describe the functions of different parts of flowering plants: roots, stem / trunk, leaves and flowers	3
	B3b explore the requirements of plants for life and growth (air, light, water, nutrients from soil and room to grow) and how they vary from plant to plant*	3
	B3c investigate the way in which water is transported within plants*	3
	B3d explore the part that flowers play in the life cycle of flowering plants, including pollination, seed formation and seed dispersal*	3
Living things and their habitats (B)	B4a recognise that living things can be grouped in a variety of ways	4
	B4b explore and use classification keys to help group, identify and name a variety of living things in their local and wider environment*	4
	B4c recognise that environments can change and that this can sometimes pose dangers to living things	4
	B5a describe the differences in the life cycle of a mammal, an amphibian, an insect and a bird	5
	B5b describe the life process of reproduction in some plants and animals	5
	B6a describe how living things are classified into broad groups according to common observable characteristics and based on similarities and differences, including micro-organisms, plants and animals	6
	B6b give reasons for classifying plants and animals based on specific characteristics	6
Animals including humans (B)	B3e identify that animals, including humans, need the right types and amount of nutrition, and that they cannot make their own food; they get nutrition from what they eat	3

Topic	Strand from programme of study	Year group
Animals including humans (B) (continued)	B3f identify that humans and some other animals have skeletons and muscles for support, protection and movement	3
	B4d describe the simple functions of the basic parts of the digestive system in humans	4
	B4e identify the different types of teeth in humans and their simple functions	4
	B4f construct and interpret a variety of food chains, identifying producers, predators and prey	4
	B5c describe the changes as humans develop to old age	5
	B6c identify the main parts of the human circulatory system, and describe the functions of the heart, blood vessels and blood	6
	B6d recognise the impact of diet, exercise, drugs and lifestyle on the way their bodies function	6
	B6e describe the ways in which nutrients and water are transported within animals, including humans	6
Evolution and inheritance (B)	B6f recognise that living things have changed over time and that fossils provide information about living things that inhabited the Earth millions of years ago	6
	B6g recognise that living things produce offspring of the same kind, but normally offspring vary and are not identical to their parents	6
	B6h identify how animals and plants are adapted to suit their environment in different ways and that adaptation may lead to evolution	6

4.2 Content domain for chemistry

Table 3: Content domain for chemistry

Topic	Strand from programme of study	Year group
Rocks (C)	C3a compare and group together different kinds of rocks on the basis of their appearance and simple physical properties*	3
	C3b describe in simple terms how fossils are formed when things that have lived are trapped within rock	3
	C3c recognise that soils are made from rocks and organic matter	3
States of matter (C)	C4a compare and group together materials according to whether they are solids, liquids or gases	4
	C4b observe that some materials change state when they are heated or cooled, and measure or research the temperature at which this happens in degrees Celsius (°C)*	4
	C4c identify the part played by evaporation and condensation in the water cycle and associate the rate of evaporation with temperature	4
Properties and changes of materials (C)	C5a compare and group together everyday materials on the basis of their properties, including hardness, solubility, transparency, conductivity (electrical and thermal), and response to magnets*	5
	C5b know that some materials will dissolve in liquid to form a solution, and describe how to recover a substance from a solution	5
	C5c use knowledge of solids, liquids and gases to decide how mixtures might be separated, including through filtering, sieving and evaporating	5
	C5d give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials including metals, wood and plastic	5
	C5e demonstrate that dissolving, mixing and change of state are reversible changes*	5
	C5f explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda	5

4.3 Content domain for physics

Table 4: Content domain for physics

Topic	Strand from programme of study	Year group
Light (P)	P3a recognise that they need light in order to see things and that dark is the absence of light	3
	P3b notice that light is reflected from surfaces	3
	P3c recognise that light from the sun can be dangerous and that there are ways to protect their eyes	3
	P3d recognise that shadows are formed when the light from a light source is blocked by an opaque object	3
	P3e find patterns in the way that the size of shadows change	3
	P6a recognise that light appears to travel in straight lines	6
	P6b use the idea that light travels in straight lines to explain that objects are seen because they give out or reflect light into the eye	6
	P6c explain that we see things because light travels from light sources to our eyes or from light sources to objects and then to our eyes	6
Forces and magnets (P)	P6d use the idea that light travels in straight lines to explain why shadows have the same shape as the objects that cast them	6
	P3f compare how things move on different surfaces	3
	P3g notice that some forces need contact between two objects, but magnetic forces can act at a distance	3
	P3h observe how magnets attract or repel each other and attract some materials and not others*	3
	P3i compare and group together a variety of everyday materials on the basis of whether they are attracted to a magnet, and identify some magnetic materials*	3
	P3j describe magnets as having two poles	3
P3k predict whether two magnets will attract or repel each other, depending on which poles are facing	3	

Topic	Strand from programme of study	Year group
Sound (P)	P4a identify how sounds are made, associating some of them with something vibrating	4
	P4b recognise that vibrations from sounds travel through a medium to the ear	4
	P4c find patterns between the pitch of a sound and features of the object that produced it*	4
	P4d find patterns between the volume of a sound and the strength of the vibrations that produced it*	4
	P4e recognise that sounds get fainter as the distance from the sound source increases	4
Electricity (P)	P4f identify common appliances that run on electricity	4
	P4g construct a simple series electrical circuit*, identifying and naming its basic parts, including cells, wires, bulbs, switches and buzzers	4
	P4h identify whether or not a lamp will light in a simple series circuit, based on whether or not the lamp is part of a complete loop with a battery	4
	P4i recognise that a switch opens and closes a circuit and associate this with whether or not a lamp lights in a simple series circuit	4
	P4j recognise some common conductors and insulators, and associate metals with being good conductors	4
	P6e associate the brightness of a lamp or the volume of a buzzer with the number and voltage of cells used in the circuit	6
	P6f compare and give reasons for variations in how components function, including brightness of bulbs, loudness of buzzers and on / off position of switches	6
	P6g use recognised symbols when representing a simple circuit in a diagram	6
Forces (P)	P5e explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object	5
	P5f identify the effects of air resistance, water resistance and friction that act between moving surfaces	5

Topic	Strand from programme of study	Year group
Forces (P) (continued)	P5g recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect	5
Earth and space (P)	P5a describe the movement of the Earth, and other planets, relative to the Sun in the solar system	5
	P5b describe the movement of the Moon relative to the Earth	5
	P5c describe the Sun, Earth and Moon as approximately spherical bodies	5
	P5d use the idea of the Earth's rotation to explain day and night and the apparent movement of the sun across the sky	5

4.4 Content domain for 'Working scientifically'

'Working scientifically' replaces the area of 'scientific enquiry' in the national curriculum (1999) document. Between 2003 and 2012, 'scientific enquiry' had a major emphasis in the science national curriculum tests and in the science sampling tests, with 40 per cent of all questions in the tests being attributed to strands from this area of the programme of study. In the national curriculum (2014), 'Working scientifically' is considered an integral part of the other three core areas of science and will no longer be assessed as a separate domain. Questions will be integrated within the contexts of biology, chemistry and physics.

The content domain for 'Working scientifically' also includes strands of the programme of study that cannot be assessed or can only be partially assessed in the key stage tests due to their direct association with practical skills or experiences linked to school location. These are marked with an asterisk (*) in Table 5 and summarised and explained in Table 6.

Table 5: Content domain for 'Working scientifically'

Topic	Strand from programme of study	Key stage (lower / upper)
Planning	WSLa asking relevant questions and using different types of scientific enquiries to answer them*	lower
	WSUa planning different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary	upper
Carrying out	WSLb setting up simple practical enquiries, and comparative and fair tests*	lower

Topic	Strand from programme of study	Key stage (lower / upper)
Measuring	WSLc making systematic and careful observations and, where appropriate, taking accurate measurements using standard units, using a range of equipment, including thermometers and data loggers*	lower
	WSU_b taking measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate*	upper
Recording	WSLd gathering, recording, classifying and presenting data in a variety of ways to help in answering questions*	lower
	WSLe recording findings using simple scientific language, drawings, labelled diagrams, keys, bar charts, and tables	lower
	WSUc recording data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar and line graphs	upper
Concluding	WSLg using results to draw simple conclusions, make predictions for new values, suggest improvements and raise further questions	lower
	WSLh identifying differences, similarities or changes related to simple scientific ideas and processes	lower
	WSLi using straightforward scientific evidence to answer questions, or to support their findings	lower
	WSUf identifying scientific evidence that has been used to support or refute ideas or arguments	upper
Reporting	WSLf reporting on findings from enquiries, including oral and written explanations, displays or presentations of results and conclusions*	lower
	WSUe reporting and presenting findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations*	upper
Further work	WSUd using test results to make predictions to set up further comparative and fair tests*	upper

4.5 Elements of the curriculum that cannot be assessed fully

The table below provides more detailed information about the strands marked with an asterisk in Tables 2 to 5, which cannot be assessed or can only partially be assessed in a paper-based test due to the more practical nature of the strand. Table 6 describes the aspects of each strand that will be assessed on paper and identifies if there are any aspects that are not assessed at all.

Table 6: Elements of the curriculum that cannot be assessed fully

Content domain reference		Explanation of what is and what is not assessed in the paper-based tests
Years 3-4	Years 5-6	
Living things and their habitats - explore and use classification keys to help group, identify and name a variety of living things in their local and wider environment (B4b)		This requires access to, and interaction with the local environment. Questions about the pupil's wider environment, such as using classification keys to group, name or identify living things could be asked in a paper-based test.
Plants - explore the requirements of plants for life and growth (air, light, water, nutrients from soil, and room to grow) and how they vary from plant to plant (B3b)		Whilst 'exploration' of plants' requirements cannot be done in a paper test pupils' knowledge of the requirements and how they may vary can be tested.
Plants - investigate the way in which water is transported within plants (B3c)		Whilst 'investigation' of water transport in plants cannot be done in a paper test pupils' knowledge of the phenomenon can be tested.
Plants - explore the part that flowers play in the life cycle of flowering plants, including pollination, seed formation and seed dispersal (B3d)		Whilst 'exploration of the roles of flowers cannot be done in a paper test pupils' knowledge of the phenomenon can be tested.

Content domain reference		Explanation of what is and what is not assessed in the paper-based tests
Years 3-4	Years 5-6	
Rocks - compare and group together different kinds of rocks on the basis of their appearance and simple physical properties (C3a)		Because classification is based on observed features of actual rock specimens, pupils should ideally physically handle rock specimens to ascertain the rocks' features. However, classification of rocks can be assessed using secondary data in a paper-based test.
States of matter - observe that some materials change state when they are heated or cooled, and measure or research the temperature at which this happens in degrees Celsius (°C) (C4b)		Parts of this strand would be better assessed during practical investigations. For example, measuring or researching the temperature at which materials change state requires practical work and access to other information sources (such as textbooks and the internet). These skills cannot be fully assessed in a paper-based test. However, questions may be asked that draw upon a pupil's understanding, gained through experience, of heating and cooling materials.
Electricity - construct a simple series electrical circuit, identifying and naming its basic parts, including cells, wires, bulbs, switches and buzzers (P4g)		This requires practical equipment to assess validly. However, the identification, naming and drawing of electrical components and circuits can be assessed in a paper-based test.

Content domain reference		Explanation of what is and what is not assessed in the paper-based tests
Years 3-4	Years 5-6	
Forces and magnets - observe how magnets attract or repel each other and attract some materials and not others (P3h)		<p>Whilst 'observation' of magnets interacting with each other cannot be actually done in a paper test, pupils' knowledge and understanding of the phenomena can be tested.</p> <p>It would be <i>better</i> tested in a performance assessment.</p> <p>It is more difficult to test the second part of the strand. We <i>can</i> test knowledge of what everyday objects should be attracted if we use commonplace objects, but we need to think very carefully about which objects are referred to in an item. This part of the strand would definitely be better tested in a performance assessment.</p>
Forces and magnets - compare and group together a variety of everyday materials on the basis of whether they are attracted to a magnet, and identify some magnetic materials (P3i)		<p>Because classification is based on observed features of actual everyday materials, pupils should ideally physically handle everyday materials to ascertain the everyday materials' features. However, classification of everyday materials can be assessed using secondary data in a paper-based test.</p>
Sound - find patterns between the pitch of a sound and features of the object that produced it (P4c)		<p>This would be better tested as a performance assessment. However, knowledge of the phenomenon can be assessed in a paper test.</p>
Sound - find patterns between the volume of a sound and the strength of vibrations that produced it (P4d)		<p>This would be better tested as a performance assessment. However, knowledge of the phenomenon can be assessed in a paper test.</p>
Planning - asking relevant questions and using different types of scientific enquiries to answer them (WSLa)		<p>This requires a discursive approach between the pupil and their teacher.</p> <p>Pupils are assessed on their understanding of different types of scientific enquiry, including fair tests, through WSUa in the paper-based test.</p>

Content domain reference		Explanation of what is and what is not assessed in the paper-based tests
Years 3-4	Years 5-6	
Carrying out - setting up simple practical enquiries, and comparative and fair tests (WSLb)		This requires the pupil to use practical equipment, including making measurements and being able to either follow instructions or make decisions about a procedure. This is not possible in a paper-based test.
Using test results to make predictions to set up further comparative and fair tests (WSUd)		The strand would be better assessed in a performance assessment although aspects of it could be assessed in a paper-based tests.
Measuring - making systematic and careful observations and, where appropriate, taking accurate measurements using standard units, using a range of equipment, including thermometers and data loggers (WSLc)		This requires pupils to use actual equipment over a period of time. It also requires pupils to determine when readings should be taken (i.e. to manage their time during a practical activity). Pupils can be assessed on reading measurements from diagrams or photographs of equipment and also using correct units in a paper-based test.
	Measuring - taking measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate (WSUb)	This requires the pupil to use equipment and to determine how and when to take readings. Pupils can be assessed on their understanding of when and why repeat readings need to be taken in a paper-based test.
Recording - gathering, recording, classifying and presenting data in a variety of ways to help in answering questions (WSLd)		This requires the pupil to gather, process and present their own data based on a specific investigative question, which is not possible in a paper-based test. Pupils can be assessed on their ability to use a variety of formats to record specific data provided to them in a test question and use data to answer questions relating to a given investigation in a paper-based test.

Content domain reference		Explanation of what is and what is not assessed in the paper-based tests
Years 3-4	Years 5-6	
Reporting - reporting on findings from enquiries, including oral and written explanations, displays or presentations of results and conclusions (WSLf)		This requires the pupil to have carried out their own investigative work and to present information in ways that are not possible in a paper-based test.
	Reporting - reporting and presenting findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations (WSUe)	This strand would take too long and some activities (for example, giving a presentation) would not be possible in a test situation. Pupils can be asked to write conclusions, describe and / or explain causal relationships and to provide scientific explanations for a given set of data in a paper-based test.
	Properties and changes of materials - demonstrate that dissolving, mixing and changes of state are reversible changes (C5e)	Whilst 'demonstration' cannot be actually done in a paper test, pupils' knowledge and understanding of the phenomena can be tested. It would be <i>better</i> tested in a performance assessment.
	Properties and changes of materials - compare and group together everyday materials on the basis of their properties, including their hardness, solubility, transparency, conductivity (electricity and thermal), and response to magnets (C5a)	Because classification is based on observed or tested properties, pupils need to physically handle materials to do this. Pupils can classify materials based on their properties using secondary data and can be assessed on their understanding of properties of materials in a paper-based test.

5. Cognitive domain

The cognitive domain seeks to make the thinking skills and intellectual processes required for the key stage 2 science sampling test explicit. Each question will be rated against the two strands of the cognitive domain listed in Tables 7 and 8.

The cognitive domain will be used during test development to ensure comparability of demand, as well as difficulty for tests over successive years.

The cognitive domain provides a framework to which the facts, processes and interpretations that need to be tested in science can be matched. It allows broad testing of different aspects of pupils' scientific knowledge, including basic recall (for example, of terminology); interpretation of data; and formulation of original responses to novel scenarios that draw on a broad scientific knowledge and skills base. Items have been grouped as follows:

- items that assess factual knowledge (Knowledge and comprehension)
- items that require pupils to deduce an answer from presented data, or produce an answer based on use of scientific knowledge in a familiar or straightforward context (Application and analysis)
- items that require pupils to select which knowledge is appropriate, and possibly produce an answer that is original and tailored to a specific scenario (Synthesis and evaluation)

The strands used to determine cognitive domain are:

- cognitive complexity
- response strategy

Items will be written for each strand of the programme of study as outlined in the content domain and rated according to the two strands above. As far as possible all strands of the programme of study will be assessed at each rating for both strands. A detailed explanation of each of the two strands follows in sections 5.1 and 5.2.

5.1 Complexity rating

The complexity scale is described in Table 7. Recall of knowledge is considered to place the lowest level of cognitive demand on a pupil in order to answer a question. Evaluation has the highest demand, requiring pupils to demonstrate complex thought processes in order to put forward and argue their reasoning, supported by their knowledge and understanding. There are three ratings within this strand (low to high).

Within the science sampling matrix as a whole, items will cover each rating for cognitive demand. Some strands of the content domain will lend themselves to being assessed at particular ratings for cognitive demand.

Table 7: Cognitive complexity rating scale

Item dimension - complexity	Knowledge and comprehension (low)	Application and analysis	Synthesis and evaluation (high)
The complexity of each component operation or idea and the links between them	Remembers previously learned information and demonstrates an understanding of the facts	Applies knowledge to actual situations, breaks down information into simpler parts and finds evidence to support generalisations	Compiles component ideas into a new whole or proposes alternative solutions. Makes and defends judgements based on evidence
	Recalls or describes simple factual information as required Makes straightforward observations of features or objects	Applies knowledge to given contexts Provides an explanation based on knowledge or simple evidence Identifies patterns in data and makes comparisons	Makes links between different sources of evidence or information to provide an explanation Makes inferences and deductions from information given and own knowledge
	Reads or extracts information from simple data sources or text or diagrams	Makes predictions based on data given Analyses data sources	Draws conclusions from evidence and relates to scientific understanding

5.2 Response strategy rating

The response strategy is considered within a scale that ranges from closed or selected response formats to extended response formats. The response strategies are grouped into three ratings for science as shown in Table 8.

Table 8: Response strategy rating scale

	1. Selected response (low)	2. Short constructed response	3. Extended constructed response (high)
The extent to which a candidate is required to devise a strategy for tackling and answering an item	The response format is given in the question information and the strategy for responding is clearly provided	The response format may not be given in the question information but the strategy for how the pupil determines the answer is clearly provided	Pupils are required to construct their own extended response
	Multiple choice, matching item, true / false style, circle, sequencing, ticking cells in a table, selecting correct data from a table, identifying from a key	Short open response items, for example, naming processes, parts, objects and variables Describing, giving one difference, way or reason, completing bar or line graphs	Longer open response items, that are likely to be two lines of writing, for example, describing relationships or providing explanations
		Drawing or completing diagrams by drawing arrows or circuit diagrams	

6. Test specification

This section provides details of each test component and the sampling matrix design as a whole. The test will be administered on paper by external administrators and externally marked.

6.1 Summary of test and matrix design

Overall, a question pool totalling 330 marks will be selected. These questions will be divided into five papers for each content area (biology, chemistry and physics), giving a total of 15 test papers worth 22 marks each.

Each pupil will sit one paper from each content area, giving a total of three papers worth 66 marks.

Pupils will be given 25 minutes to complete each paper. The total testing time will be 75 minutes.

Table 9: Overall format of the item pool

Content area	Number of marks	Number of versions
Biology	110	5
Chemistry	110	5
Physics	110	5
Total	330	15

Table 10: Format of the test for each pupil

Component	Description	Number of papers	Number of marks	Approximate timing of component
Test paper b	questions in a biology context	1 (from 5 versions)	22	25 minutes
Test paper c	questions in a chemistry context	1 (from 5 versions)	22	25 minutes
Test paper p	questions in a physics context	1 (from 5 versions)	22	25 minutes
	Total	3	66	75 minutes

Each pupil takes three papers: one biology, one chemistry and one physics. Table 11 shows an example of how the different papers will be combined within each of the 15 possible test combinations a pupil could be given: the numbers in the cells represent the version number and the letter in brackets represents the component (biology, chemistry or physics).

Table 11: Matrix design

Combination	Order of administration		
	1st	2nd	3rd
1	1 (b)	6 (c)	11 (p)
2	2 (b)	7 (c)	12 (p)
3	3 (b)	8 (c)	13 (p)
4	4 (b)	9 (c)	14 (p)
5	5 (b)	10 (c)	15 (p)
6	6 (c)	13 (p)	2 (b)
7	7 (c)	14 (p)	3 (b)
8	8 (c)	15 (p)	4 (b)
9	9 (c)	11 (p)	5 (b)
10	10 (c)	12 (p)	1 (b)
11	11 (p)	3 (b)	10 (c)
12	12 (p)	4 (b)	6 (c)
13	13 (p)	5 (b)	7 (c)
14	14 (p)	1 (b)	8 (c)
15	15 (p)	2 (b)	9 (c)

This design may be adapted in each assessment year in order to include other papers of questions for specific purposes, such as TIMSS material and trial material. These materials will form additional papers which will be added to the design.

6.2 Breadth and emphasis

The content and cognitive domains for the science tests are specified in sections 4 and 5. Although each element may not be included within each set of booklets administered to a pupil, the full range of content detailed in this document will be assessed over the full range of booklets. Consolidation of the key stage 1 material is assumed within the

key stage 2 programme of study and therefore, material from key stage 1 may appear within the key stage 2 test. The questions in each test will be placed in approximate order of difficulty. Items within questions are not necessarily in order of difficulty as they need to fit within the context and show a follow through for a storyline (for example, an investigation from planning to conclusion). Where possible, however, easier items are positioned at the start of a question to familiarise pupils with each context.

The following sections show the proportion of marks attributed to each of the areas of the content and cognitive domains, both in the item pool as a whole and in the test administered to each pupil.

6.2.1 Profile of content domain

Questions are designed to be related to one of the three content areas of biology, chemistry and physics. Table 12 shows the proportion of marks in the item pool expected to be related to each of the three core content areas. Each content area will contribute one third of the marks in the item pool.

Table 12: Profile of marks by content area

Content area	Number of marks in item pool	Number of papers in item pool	Number of marks per paper
Biology	110 (33%)	5	22
Chemistry	110 (33%)	5	22
Physics	110 (33%)	5	22
Total in test	330	15	66

In 2016, only elements that are common to the old and new curriculum documents will be assessed from the Year 3-4 content areas.

Within each content area, some items only assess the related strand (in the national curriculum), while other items assess the related strand plus 'Working scientifically'.

Table 13 shows the profile of the 'Working scientifically' strand.

Table 13: Profile of marks assessing 'Working scientifically'

Number of marks in item pool	Minimum number of marks per paper
83–115 (25%–35%)	5

6.2.2 Profile of cognitive domain

Items will be rated in terms of demand against both strands of the cognitive domain (see section 5).

Table 14 shows the expected proportion of marks classified at each level of cognitive complexity within the item pool as a whole. No specific restrictions are placed on the distribution of marks within each individual paper but it is intended that each paper covers a range of items at different levels of complexity.

Table 14: Profile of marks by cognitive complexity

Cognitive complexity	Number of marks in item pool	Percentage of marks in item pool
Knowledge and comprehension	99-165	30-50%
Application and analysis	99-165	30-50%
Synthesis and evaluation	33-99	10-30%

Table 15 shows the expected proportion of marks classified at each level of response strategy within the item pool as a whole. No specific restrictions are placed on the distribution of marks within each individual paper but it is intended that each paper covers a range of different types of item.

Table 15: Profile of marks by response strategy

Response strategy	Number of marks in item pool	Percentage of marks in item pool
Selected response	116-165	35-50%
Short answer	99-149	30-45%
Extended response	50-99	15-30%

6.3 Format of items and responses

All three types of paper (biology, chemistry, physics) contain the same range of item types.

There are two broad formats for item type: selected response and constructed response.

Selected response items, where pupils are required to select a response from a limited range of options, including:

- multiple choice items
- matching items
- true / false items

Constructed response items are where pupils are required to write a short answer on their own. Short answer items and extended response items are both examples of constructed response items.

Short-answer items, where pupils are required to produce a short response and no options have been given. Examples of short answer items include:

- naming an object or process
- completing a sentence with a missing word
- completing a table or chart
- labelling a diagram or key

Extended response items, where pupils are required to construct their own longer response. Examples of extended response items include:

- explanations
- justifications for previous answers
- various elements of planning an investigation
- graphing or describing a data set

6.4 Marking and mark schemes

The test will be externally marked on screen by trained markers.

The tests will be administered securely and kept confidential. Mark schemes will be developed alongside the test materials so that the tests can be marked reliably, however they will not be published.

In each year the science sampling tests are administered in schools, a sample of questions will be published with an accompanying mark scheme.

The mark scheme will give general principles for marking the papers to ensure consistency of marking together with specific guidance for each item.

The mark scheme will provide the total number of marks available for each question and the criteria by which markers should award the marks. Where multiple correct answers are possible, examples of different types of correct answer will be given. Additional guidance will indicate minimally acceptable responses and unacceptable responses, where applicable.

For all questions, the mark schemes will be developed during the test development process and will combine the expectations of experts with examples of pupils' responses obtained during trialling.

For multi-mark questions, the mark scheme will provide details of how partial credit can be awarded.

The mark schemes will contain the following information:

- a content domain reference
- marks – the maximum number of marks for each item in a question
- requirements – for open response items this will include a generic statement describing the type or types of responses that will enable a pupil to gain credit, followed by a number of exemplar responses to indicate the types of answer a pupil may write. For selected response items this will indicate the response required for the pupil to gain credit
- allowable responses – this section will provide exemplars of allowable responses. Allowable responses are minimally acceptable and are usually not as good from a scientific perspective
- additional guidance – this section will give information on response types that are not creditworthy because they are either insufficient or incorrect

6.5 Reporting

Analysis will be undertaken using the combined data from all pupils in the sample in order to produce a scaled score representing the performance of the sample as a whole. The purposes of translating raw scores onto scaled scores for science sampling are twofold:

- Performance can be reported as a whole, having taken into account the varying difficulties of the specific test combinations taken by different pupils.
- Scaled scores retain the same meaning from one year to the next so a particular scaled score reflects the same level of attainment in one year of administration as in the previous, allowing national performance to be compared across years.

Additionally, an estimate of the proportion of pupils who have achieved the required standard on the test will be produced. A standard-setting exercise will be conducted on the first live test in 2016 in order to determine the scaled score needed for a pupil to be considered to have met the standard. This process will be facilitated by the performance descriptor in section 6.7, which defines the performance level required to meet the standard. In subsequent years, the standard will be maintained using appropriate statistical methods to translate performance across a new item pool into scaled scores. The scaled score required to achieve the expected standard will always remain the same.

6.6 Desired psychometric properties

The focus of the outcome of the science sampling model is to provide an estimate of the proportion of pupils nationally who would have achieved the required standards. While it is important to minimise the standard errors of measurement throughout the scale, it is particularly important to do so around the threshold of the expected standard.

6.7 Performance descriptor

This performance descriptor describes the typical characteristics of pupils whose performance is at the threshold for the expected standard at the end of key stage 2. Pupils who achieve the expected standard in the tests have demonstrated sufficient knowledge to be well placed to succeed in the next phase of their education having studied the full key stage 2 programme of study in science. This performance descriptor will be used by teachers to set the standards on the new tests following their first administration in 2016. It is not intended to be used to support teacher assessment since it reflects only the elements of the programme of study that can be assessed in a paper-based test (see the content domain in section 4).

The complete suite of key stage 2 science sampling tests taken in each live sample year includes questions assessing the entire key stage 2 programme of study in the national curriculum (2014) including the 'Working scientifically' strand. Each pupil will only take three tests. It is therefore the aggregated results from the complete test suite that will provide an indication of how pupils are performing in science across England. It is assumed that pupils working at the threshold will be generally secure in the scientific knowledge and skills they acquired at key stage 1.

6.7.1 Overview

Pupils working at the expected standard will be able to engage with all questions within the test. However, they will not always achieve full marks on each question, particularly if they are working at the threshold of the expected standard, or if the question has a high cognitive demand.

Questions will range from those requiring recall of facts to those requiring synthesis and evaluation. There will be a variety of question formats including selected response, short answer and constructed response where no strategy is provided within the question.

Question difficulty will be affected by the scientific content (including the 'Working scientifically' strand) and by the different strands of the cognitive domain, such as question complexity and the extent to which support is given in the question to help pupils identify or construct their response. This should be borne in mind when considering the remainder of this performance descriptor.

The following sections describe examples of the threshold standard, most of which a typical pupil in Year 6 should be able to demonstrate. It is recognised that different pupils will exhibit different strengths, so this is intended as a general guide rather than a prescriptive list. It is also recognised that the topics in the science national curriculum (2014) are described by year group, therefore a topic covered in a discrete year may not be covered again towards the end of key stage 2.

The content in the national curriculum (2014) has been divided up into 'Working scientifically' and the three scientific disciplines. The performance descriptors that follow reflect this.

6.7.2 Working scientifically

Pupils should be able to recall, use and apply their knowledge, understanding and skills in 'Working scientifically' to familiar and unfamiliar contexts. Pupils should be able to (with no order of priority or hierarchy intended):

- recall and use appropriately terminology such as accurate, conclusion, evidence, fair test, method, observe, pattern, prediction, reliable, results, supports (evidence) and variable
- identify the most appropriate approach for answering scientific questions and select the most appropriate equipment and sources of evidence needed for a task
- know when to use different types of scientific enquiry, make careful observations, take accurate measurements or readings using the appropriate units as required and identify when to repeat measurements, if necessary, to ensure given results are reliable
- record, present and interpret data from different sources, using a range of methods, including tables, graphs (bar charts and line graphs), diagrams and keys
- apply their understanding of scientific concepts to draw valid conclusions from data
- use data to make predictions for missing values
- identify or use evidence to support or refute ideas or arguments
- recognise the validity and reliability of evidence and the difference between fact and opinion

6.7.3 Biology

Pupils should be able to recall, use and apply their knowledge and understanding to familiar and unfamiliar contexts. They should draw conclusions, make simple evaluations and synthesise information.

Pupils should be able to (with no order of priority or hierarchy intended) respond to the majority of statements below, but may be less secure in areas that have not been covered since Years 3 or 4:

- recall and use appropriately terminology such as adaptation, circulatory system, classification, consumer, evolution, function, germination, invertebrates, nutrients, pollination, predator, prey, producer, reproduction, seed dispersal and vertebrates
- describe the processes involved in different stages of the flowering plant's life cycle and the function of different parts of flowering plants
- describe how water and nutrients are transported in plants
- compare the requirements of plants and animals to live and grow well
- compare the similarities and differences between the life cycles of different animals (including humans and other mammals, birds, amphibians, and insects)
- describe the functions of parts of the digestive system in animals
- describe the functions of the main parts of the circulatory system (including the transport of nutrients and water) in animals

- describe the functions of the skeleton and muscles in animals
- describe the effects of diet, exercise, drugs and lifestyle on how our bodies function in the long and short term
- construct and interpret food chains; use keys to group, classify or identify living things, and construct simple dichotomous keys
- describe the main characteristics used to group plants, animals and micro-organisms according to the main groups (vertebrates, invertebrates, birds, mammals, reptiles, fish and amphibians) in the classification system
- explain how a change in an environment may have an impact on living things
- identify that there is variation between offspring and between offspring and their parents because of differences in inherited characteristics
- describe how plants and animals have adapted to their environment and how this may have led to their evolution
- describe how living things have changed over time and that fossils provide information about living things in the past

6.7.4 Chemistry

Pupils should be able to recall, use and apply their knowledge and understanding to familiar and unfamiliar contexts. They should draw conclusions, make simple evaluations and synthesise information.

Pupils should be able to (with no order of priority or hierarchy intended) respond to the majority of statements below, but may be less secure in areas that have not been covered since Years 3 or 4:

- recall and use appropriately terminology such as condensation, °C (degrees Celsius), evaporation, filtering, freezing, insoluble, melting, mixture, non-reversible, properties, reversible, solidifying, soluble and solution
- compare the characteristics of different states of matter (solids, liquids and gases)
- describe how materials can change state with reference to temperature, and explain everyday phenomena (including the water cycle) where changes of state occur
- classify and group materials according to properties, such as appearance (for rocks), hardness, solubility, transparency, conductivity and magnetism
- describe the advantages and disadvantages for the uses of everyday materials based on an understanding of their properties using appropriate terminology
- identify and recognise everyday phenomena where dissolving occurs
- describe how to appropriately separate different mixtures of materials, including solutions
- identify and compare reversible and non-reversible changes
- describe in simple terms how fossils are formed
- describe the composition of soil

6.7.5 Physics

Pupils should be able to recall, use and apply their knowledge and understanding to familiar and unfamiliar contexts. They should draw conclusions, make simple evaluations and synthesise information.

Pupils should be able to (with no order of priority or hierarchy intended) respond to the majority of statements below, but may be less secure in areas that have not been covered since Years 3 or 4:

- recall and use appropriately terminology such as air resistance, attraction, conductor, friction, gravity, insulator, newtons (N), opaque, orbit, pitch, repulsion, sphere, translucent, transparent, vibration, voltage, volume and water resistance
- explain how we see other objects (from a single reflection) and represent this in simple diagrammatic form
- explain shadow formation and how the size of shadows may change
- explain how sounds are made and describe how they require a medium to travel through from the source to the ear
- describe how volume can be changed with reference to vibration
- describe how the features of an object determine the pitch of a sound
- describe the shape of bodies (spheres) in the solar system and the movement of bodies in the solar system relative to each other
- explain how day and night, including the apparent movement of the Sun across the sky, are related to the Earth's rotation
- draw or complete a simple series circuit diagram using recognised symbols including straight lines for wires
- explain how changes made to a circuit can affect how it works
- identify and describe the effects of contact and non-contact forces on moving and stationary objects
- describe the effects of magnets on magnets and other materials
- describe how simple pulleys, levers, springs and gears increase the effects of a force

7. Diversity and inclusion

The Equality Act 2010 sets out the principles by which the national curriculum assessment and its associated development activities are conducted. During the development of the tests, STA's test development division will make provision to overcome barriers to fair assessment for individuals and groups wherever possible.

National curriculum tests will also meet Ofqual's core regulatory criteria. One of the criteria refers to the need for assessment procedures to minimise bias: 'The assessment should minimise bias, differentiating only on the basis of each learner's ability to meet national curriculum requirements' (Regulatory framework for national assessment, published by Ofqual 2011).

The end of key stage 2 science sampling test should:

- use appropriate means to allow all pupils to demonstrate their knowledge and skills in biology, chemistry and physics
- provide a suitable challenge for all pupils and give every pupil the opportunity to achieve as high a standard as possible
- provide opportunities for all pupils to achieve, irrespective of gender, disability or special educational need, social, linguistic or cultural backgrounds
- use materials that are familiar to pupils and for which they are adequately prepared
- not be detrimental to pupils' self-esteem or confidence
- be free from stereotyping and discrimination in any form

The test development process uses the principles of universal design, as described in the 'Guidance on the principles of language accessibility in national curriculum assessments' (New language accessibility guidance, published by Ofqual 2012).

In order to improve general accessibility for all pupils, where possible, questions will be placed in order of difficulty. As with all national curriculum tests, attempts have been made to make the question rubric as accessible as possible for all pupils, including those who experience reading and processing difficulties, and those for whom English is an additional language, while maintaining an appropriate level of demand to adequately assess the content. This includes applying the principles of plain English and universal design wherever possible, conducting interviews with pupils, and taking into account feedback from expert reviewers.

For each test in development, expert opinions on specific questions are gathered, for example at inclusion panel meetings which are attended by experts and practitioners from across the fields of disabilities and special educational needs. This provides an opportunity for some questions to be amended or removed in response to concerns raised.

Issues likely to be encountered by pupils with specific learning difficulties have been considered in detail. Where possible, features of questions that lead to construct irrelevant variance (for example, question formats and presentational features) have been considered and questions have been presented in line with best practice for dyslexia and other specific learning difficulties.

7.1 Access arrangements

The full range of access arrangements applicable to key stage 2 assessments as set out in the ARA will be available to eligible pupils as required.

Appendix: Glossary of terminology used in the test framework

cognitive domain	<p>Cognitive processes refer to the thinking skills and intellectual processes that occur in response to a stimulus. The cognitive domain makes explicit the thinking skills associated with an assessment.</p> <p>The cognitive domain, as shown in this framework, also identifies other factors that may influence the difficulty of the questions.</p>
component	<p>A section of a test, presented to pupils as a test paper or test booklet. Some tests may have two or more components that each pupil needs to sit in order to complete the test. The key stage 2 science sampling test comprises three components.</p>
construct irrelevant variance	<p>Construct irrelevant variance is the variation in pupils' test scores that does not come from their knowledge of the content domain. It can result in pupils gaining fewer marks than their knowledge would suggest or lead to the award of more marks than their knowledge alone would deserve.</p> <p>The former can occur, for example, when questions in a mathematics test also unintentionally measure reading ability. The latter often occurs when unintended clues within questions allow pupils to answer correctly without having the required subject knowledge.</p>
content domain	<p>The body of subject knowledge to be assessed by the test.</p>
distribution	<p>The range of possible scaled scores.</p>
domain	<p>The codified definition of a body of skills and knowledge.</p>
item	<p>The smallest unit that can be awarded a mark within a science question.</p>
mark scheme	<p>The document explaining the creditworthy responses or the criteria that must be applied to award the mark for a question in the test.</p>
matrix sampling	<p>A sampling assessment whereby different groups of pupils take different test instruments, which are all linked together in a matrix.</p>
national curriculum	<p>The statutory description of subject knowledge, skills and understanding for a key stage. The key stage 1 and 2 programmes of study are published online at https://www.gov.uk/government/publications/national-curriculum-in-england-primary-curriculum</p>
performance descriptor	<p>Description of the typical characteristics of pupils working at a particular standard. For these tests, the performance descriptor will characterise the minimum performance required to be working at the appropriate standard for the end of the key stage.</p>

question	A group of related items assessing a common context.
raw score	The unmodified score achieved on a test, following marking. In the case of these tests it is the total marks achieved. For example, if a pupil scores 27 out of 60 possible marks, the raw score is 27. Raw scores are often then converted to other measures such as percentile ranks, standardised scores, or grades.
sample	The group of pupils selected to take the test in a given year.
scaled score	A score which has been translated from a raw score onto a score on a fixed, defined scale. This allows performance to be reported on a consistent scale for all pupils, which retains the same meaning from one year to the next. Therefore, a particular scaled score reflects the same level of attainment in one year as in the previous year, having adjusted for any differences in difficulty of the specific tests.
standard	The required level of attainment in order to be classified into a particular performance category.
standard error of measurement	A reliability estimate that allows the user to determine a confidence interval around a test score. It is a measure of the distribution of scores that would be attained by a pupil had that pupil taken the test repeatedly under the same conditions.
standard setting	The process of applying the standard onto a particular test in order to determine the score required for a pupil to be classified within a particular performance category.
test framework	A document that sets out the principles, rationale and key information about the test and contains a test specification.
test specification	A detailed specification of what is to be included in a test in any single cycle of development.
truncate	To shorten by removing ends.

References

Independent review of key stage 2 testing, assessment and accountability (2011), Lord Bew.
www.gov.uk/government/collections/key-stage-2-ks2-testing-review



About this publication

Who is it for?

This document is primarily aimed at those responsible for developing the key stage 2 national curriculum test in science sampling. It may also be of interest to schools with pupils in key stage 2 and other education professionals.

What does it cover?

Detailed information to ensure an appropriate test is developed, including the:

- content domain
- cognitive domain
- test specification
- test performance descriptor

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