Department for Education

The national curriculum in England

Key stages 3 and 4 framework

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Contents

1. Introduction

1.1 This document sets out the framework for the national curriculum at key stages 3 and 4 and includes:

- contextual information about both the overall school curriculum and the statutory national curriculum, including the statutory basis of the latter
- aims for the statutory national curriculum
- statements on inclusion, and on the development of pupils' competence in numeracy and mathematics, language and literacy across the school curriculum
- programmes of study key stages 3 and 4 for all the national curriculum subjects, other than for key stage 4 science, which will follow.

2. The school curriculum in England

2.1 Every state-funded school must offer a curriculum which is balanced and broadly based[1] and which:

- promotes the spiritual, moral, cultural, mental and physical development of pupils at the school and of society, and
- prepares pupils at the school for the opportunities, responsibilities and experiences of later life.

2.2 The school curriculum comprises all learning and other experiences that each school plans for its pupils. The national curriculum forms one part of the school curriculum.

2.3 All state schools are also required to make provision for a daily act of collective worship and must teach religious education to pupils at every key stage and sex and relationship education to pupils in secondary education.

2.4 Maintained schools in England are legally required to follow the statutory national curriculum which sets out in programmes of study, on the basis of key stages, subject content for those subjects that should be taught to all pupils. All schools must publish their school curriculum by subject and academic year online.[2]

2.5 All schools should make provision for personal, social, health and economic education (PSHE), drawing on good practice. Schools are also free to include other subjects or topics of their choice in planning and designing their own programme of education.

[1] See Section 78 of the 2002 Education Act: http://www.legislation.gov.uk/ukpga/2002/32/section/78 which applies to all maintained schools. Academies are also required to offer a broad and balanced curriculum in accordance with Section 1 of the 2010 Academies Act: http://www.legislation.gov.uk/ukpga/2010/32/section/1

[2] From September 2012, all schools are required to publish information in relation to each academic year, relating to the content of the school's curriculum for each subject and details about how additional information relating to the curriculum may be obtained: http://www.legislation.gov.uk/uksi/2012/1124/made

3. The national curriculum in England

Aims

3.1 The national curriculum provides pupils with an introduction to the essential knowledge that they need to be educated citizens. It introduces pupils to the best that has been thought and said; and helps engender an appreciation of human creativity and achievement.

3.2 The national curriculum is just one element in the education of every child. There is

time and space in the school day and in each week, term and year to range beyond the national curriculum specifications. The national curriculum provides an outline of core knowledge around which teachers can develop exciting and stimulating lessons to promote the development of pupils' knowledge, understanding and skills as part of the wider school curriculum.

Structure

3.3 Pupils of compulsory school age in community and foundation schools, including community special schools and foundation special schools, and in voluntary aided and voluntary controlled schools, must follow the national curriculum. It is organised on the basis of four key stages and twelve subjects, classified in legal terms as 'core' and 'other foundation' subjects.

3.4 The Secretary of State for Education is required to publish programmes of study for each national curriculum subject, setting out the 'matters, skills and processes' to be taught at each key stage. Schools are free to choose how they organise their school day, as long as the content of the national curriculum programmes of study is taught to all pupils.

3. The national curriculum in England

3.5 The structure of the national curriculum, in terms of which subjects are compulsory at each key stage, is set out in the table below:

Figure 1 – Structure of the national curriculum

	Key stage 1	Key stage 2	Key stage 3	Key stage 4
Age 5 – 7 7 – 11 11 – 14 14 – 16 **Year groups** 1 – 2 3 – 6 7 – 9 10 – 11				
Core subjects				
English	✓	✓	✓	✓
Mathematics	✓	✓	✓	✓

Science	✓	✓	✓	✓
Foundation subjects				
Art and design	✓	✓	✓	
Citizenship			✓	✓
Computing	✓	✓	✓	✓
Design and technology	✓	✓	✓	
Languages[3]		✓	✓	
Geography	✓	✓	✓	
History	✓	✓	✓	
Music	✓	✓	✓	
Physical education	✓	✓	✓	✓

3.6 All schools are also required to teach religious education at all key stages. Secondary schools must provide sex and relationship education.

Figure 2 – Statutory teaching of religious education and sex and relationship education

	Key stage 1	Key stage 2	Key stage 3	Key stage 4
Age 5 – 7 7 – 11 11 – 14 14 – 16 **Year groups** 1 – 2 3 – 6 7 – 9 10 – 11				
Religious education	✓	✓	✓	✓
Sex and relationship education			✓	✓

[3] At key stage 2 the subject title is 'foreign language'; at key stage 3 it is 'modern foreign language'.

Key stage 4 entitlement areas

3.7 The arts (comprising art and design, music, dance, drama and media arts), design and technology, the humanities (comprising geography and history) and modern foreign language are not compulsory national curriculum subjects after the age of 14, but all pupils in maintained schools have a statutory entitlement to be able to study a subject in each of those four areas.

3.8 The statutory requirements in relation to the entitlement areas are:

- schools must provide access to a minimum of one course in each of the four

entitlement areas

- schools must provide the opportunity for pupils to take a course in all four areas, should they wish to do so
- a course that meets the entitlement requirements must give pupils the opportunity to obtain an approved qualification.

4. Inclusion

Setting suitable challenges

4.1 Teachers should set high expectations for every pupil. They should plan stretching work for pupils whose attainment is significantly above the expected standard. They have an even greater obligation to plan lessons for pupils who have low levels of prior attainment or come from disadvantaged backgrounds. Teachers should use appropriate assessment to set targets which are deliberately ambitious.

Responding to pupils' needs and overcoming potential barriers for individuals and groups of pupils

4.2 Teachers should take account of their duties under equal opportunities legislation that covers race, disability, sex, religion or belief, sexual orientation, pregnancy and maternity, and gender reassignment.[4]

4.3 A wide range of pupils have special educational needs, many of whom also have disabilities. Lessons should be planned to ensure that there are no barriers to every pupil achieving. In many cases, such planning will mean that these pupils will be able to study the full national curriculum. The SEN Code of Practice includes advice on approaches to identification of need which can support this. A minority of pupils will need access to specialist equipment and different approaches. The SEN Code of Practice outlines what needs to be done for them.

4.4 With the right teaching, that recognises their individual needs, many disabled pupils may have little need for additional resources beyond the aids which they use as part of their daily life. Teachers must plan lessons so that these pupils can study every national curriculum subject. Potential areas of difficulty should be identified and addressed at the outset of work.

4.5 Teachers must also take account of the needs of pupils whose first language is not English. Monitoring of progress should take account of the pupil's age, length of time in this country, previous educational experience and ability in other languages.

4.6 The ability of pupils for whom English is an additional language to take part in the national curriculum may be in advance of their communication skills in English. Teachers should plan teaching opportunities to help pupils develop their English and should aim to provide the support pupils need to take part in all subjects.

[4] Age is a protected characteristic under the Equality Act 2010 but it is not applicable to schools in relation to education or (as far as relating to those under the age of 18) the provision of services; it is a relevant protected characteristic in relation to the provision of services or employment (so when thinking about staff). Marriage and civil partnership are also a protected characteristic but only in relation to employment.

5. Numeracy and mathematics

5.1 Teachers should use every relevant subject to develop pupils' mathematical fluency. Confidence in numeracy and other mathematical skills is a precondition of success across the national curriculum.

5.2 Teachers should develop pupils' numeracy and mathematical reasoning in all subjects so that they understand and appreciate the importance of mathematics. Pupils should be taught to apply arithmetic fluently to problems, understand and use measures, make estimates and sense check their work. Pupils should apply

their geometric and algebraic understanding, and relate their understanding of probability to the notions of risk and uncertainty. They should also understand the cycle of collecting, presenting and analysing data. They should be taught to apply their mathematics to both routine and non-routine problems, including breaking down more complex problems into a series of simpler steps.

6. Language and literacy

6.1 Teachers should develop pupils' spoken language, reading, writing and vocabulary as integral aspects of the teaching of every subject. English is both a subject in its own right and the medium for teaching; for pupils, understanding the language provides access to the whole curriculum. Fluency in the English language is an essential foundation for success in all subjects.

Spoken language

6.2 Pupils should be taught to speak clearly and convey ideas confidently using Standard English. They should learn to justify ideas with reasons; ask questions to check understanding; develop vocabulary and build knowledge; negotiate; evaluate and

build on the ideas of others; and select the appropriate register for effective communication. They should be taught to give well-structured descriptions and explanations and develop their understanding through speculating, hypothesising and exploring ideas. This will enable them to clarify their thinking as well as organise their ideas for writing.

Reading and writing

6.3 Teachers should develop pupils' reading and writing in all subjects to support their acquisition of knowledge. Pupils should be taught to read fluently, understand extended prose (both fiction and non-fiction) and be encouraged to read for pleasure. Schools should do everything to promote wider reading. They should provide library facilities and set ambitious expectations for reading at home. Pupils should develop the stamina and skills to write at length, with accurate spelling and punctuation. They should be taught the correct use of grammar. They should build on what they have been taught to expand the range of their writing and the variety of the grammar they use. The writing they do should include narratives, explanations, descriptions, comparisons, summaries and evaluations: such writing supports them in rehearsing, understanding and consolidating what they have heard or read.

Vocabulary development

6.4 Pupils' acquisition and command of vocabulary are key to their learning and progress across the whole curriculum. Teachers should therefore develop vocabulary actively, building systematically on pupils' current knowledge. They should increase pupils' store of words in general; simultaneously, they should also make links between known and new vocabulary and discuss the shades of meaning in similar words. In this way, pupils expand the vocabulary choices that are available to them when they write. In addition, it is vital for pupils' comprehension that they understand the meanings of words they meet in their reading across all subjects, and older pupils should be taught the meaning of instruction verbs that they may meet in examination questions. It is particularly important to induct pupils into the language which defines each subject in its own right, such as accurate mathematical and scientific language.

7. Programmes of study and attainment targets

7.1 The following pages set out the statutory programmes of study and attainment targets for key stages 3 and 4 for all subjects, except for science at key stage 4. Schools are not required by law to teach the example content in [square brackets] or the content indicated as being ‘non-statutory’.

English

Purpose of study

English has a pre-eminent place in education and in society. A high-quality education in English will teach pupils to speak and write fluently so that they can communicate their

ideas and emotions to others and through their reading and listening, others can communicate with them. Through reading in particular, pupils have a chance to develop culturally, emotionally, intellectually, socially and spiritually. Literature, especially, plays a key role in such development. Reading also enables pupils both to acquire knowledge and to build on what they already know. All the skills of language are essential to participating fully as a member of society; pupils, therefore, who do not learn to speak, read and write fluently and confidently are effectively disenfranchised.

Aims

The overarching aim for English in the national curriculum is to promote high standards of language and literacy by equipping pupils with a strong command of the spoken and written word, and to develop their love of literature through widespread reading for enjoyment. The national curriculum for English aims to ensure that all pupils:

- read easily, fluently and with good understanding
- develop the habit of reading widely and often, for both pleasure and information
- acquire a wide vocabulary, an understanding of grammar and knowledge of linguistic conventions for reading, writing and spoken language
- appreciate our rich and varied literary heritage
- write clearly, accurately and coherently, adapting their language and style in and for a range of contexts, purposes and audiences
- use discussion in order to learn; they should be able to elaborate and explain clearly their understanding and ideas
- are competent in the arts of speaking and listening, making formal presentations, demonstrating to others and participating in debate.

Spoken language

The national curriculum for English reflects the importance of spoken language in pupils' development across the whole curriculum – cognitively, socially and linguistically. Spoken language continues to underpin the development of pupils' reading and writing during key stages 3 and 4 and teachers should therefore ensure pupils' confidence and competence

in this area continue to develop. Pupils should be taught to understand and use the conventions for discussion and debate, as well as continuing to develop their skills in working collaboratively with their peers to discuss reading, writing and speech across the curriculum.

Reading and writing

Reading at key stages 3 and 4 should be wide, varied and challenging. Pupils should be expected to read whole books, to read in depth and to read for pleasure and information.

Pupils should continue to develop their knowledge of and skills in writing, refining their drafting skills and developing resilience to write at length. They should be taught to write formal and academic essays as well as writing imaginatively. They should be taught to write for a variety of purposes and audiences across a range of contexts. This requires an increasingly wide knowledge of vocabulary and grammar.

Opportunities for teachers to enhance pupils' vocabulary will arise naturally from their reading and writing. Teachers should show pupils how to understand the relationships between words, how to understand nuances in meaning, and how to develop their understanding of, and ability to use, figurative language.

Pupils should be taught to control their speaking and writing consciously, understand why sentences are constructed as they are and to use Standard English. They should understand and use age-appropriate vocabulary, including linguistic and literary terminology, for discussing their reading, writing and spoken language. This involves consolidation, practice and discussion of language. It is important that pupils learn the correct grammatical terms in English and that these terms are integrated within teaching.

Teachers should build on the knowledge and skills that pupils have been taught at earlier key stages. Decisions about progression should be based on the security of pupils' linguistic knowledge, skills and understanding and their readiness to progress to the next stage. Pupils whose linguistic development is more advanced should be challenged through being offered opportunities for increased breadth and depth in reading and writing. Those who are less fluent should consolidate their knowledge, understanding and skills, including through additional practice.

Glossary

A non-statutory Glossary is provided for teachers.

Attainment targets

By the end of key stage 3, pupils are expected to know, apply and understand the matters, skills and processes specified in the relevant programme of study.

Subject content

Reading

Pupils should be taught to:

- develop an appreciation and love of reading, and read increasingly challenging material independently through:
  - reading a wide range of fiction and non-fiction, including in particular whole books, short stories, poems and plays with a wide coverage of genres, historical periods, forms and authors. The range will include high-quality works from:
    - English literature, both pre-1914 and contemporary, including prose, poetry and drama
    - Shakespeare (two plays)
    - seminal world literature
  - choosing and reading books independently for challenge, interest and enjoyment. ▪ re-reading books encountered earlier to increase familiarity with them and provide a basis for making comparisons.
- understand increasingly challenging texts through:
  - learning new vocabulary, relating it explicitly to known vocabulary and understanding it with the help of context and dictionaries
  - making inferences and referring to evidence in the text
  - knowing the purpose, audience for and context of the writing and drawing on this knowledge to support comprehension
  - checking their understanding to make sure that what they have read makes sense.
- read critically through:
  - knowing how language, including figurative language, vocabulary choice, grammar, text structure and organisational features, presents meaning ▪ recognising a range of poetic conventions and understanding how these have been used
  - studying setting, plot, and characterisation, and the effects of these ▪ understanding how the work of dramatists is communicated effectively through performance and how alternative staging allows for different interpretations of a play
  - making critical comparisons across texts
  - studying a range of authors, including at least two authors in depth each year.

Writing

Pupils should be taught to:

- write accurately, fluently, effectively and at length for pleasure and information through:
  - writing for a wide range of purposes and audiences, including:
    - well-structured formal expository and narrative essays
    - stories, scripts, poetry and other imaginative writing

- notes and polished scripts for talks and presentations
- a range of other narrative and non-narrative texts, including arguments, and personal and formal letters

- summarising and organising material, and supporting ideas and arguments with any necessary factual detail
- applying their growing knowledge of vocabulary, grammar and text structure to their writing and selecting the appropriate form
- drawing on knowledge of literary and rhetorical devices from their reading and listening to enhance the impact of their writing

- plan, draft, edit and proof-read through:
  - considering how their writing reflects the audiences and purposes for which it was intended
  - amending the vocabulary, grammar and structure of their writing to improve its coherence and overall effectiveness
  - paying attention to accurate grammar, punctuation and spelling; applying the spelling patterns and rules set out in English Appendix 1 to the key stage 1 and 2 programmes of study for English.

Grammar and vocabulary

Pupils should be taught to:

- consolidate and build on their knowledge of grammar and vocabulary through: - extending and applying the grammatical knowledge set out in English Appendix 2 to the key stage 1 and 2 programmes of study to analyse more challenging texts - studying the effectiveness and impact of the grammatical features of the texts they read
  - drawing on new vocabulary and grammatical constructions from their reading and listening, and using these consciously in their writing and speech to achieve particular effects
  - knowing and understanding the differences between spoken and written language, including differences associated with formal and informal registers, and between Standard English and other varieties of English
  - using Standard English confidently in their own writing and speech

  - discussing reading, writing and spoken language with precise and confident use of linguistic and literary terminology.[5]

Spoken English

Pupils should be taught to:

- speak confidently and effectively, including through:
  - using Standard English confidently in a range of formal and informal contexts,

including classroom discussion

- giving short speeches and presentations, expressing their own ideas and keeping to the point
- participating in formal debates and structured discussions, summarising and/or building on what has been said
- improvising, rehearsing and performing play scripts and poetry in order to generate language and discuss language use and meaning, using role, intonation, tone, volume, mood, silence, stillness and action to add impact.

[5] Teachers should refer to the Glossary that accompanies the programmes of study for English for their own information on the range of terms used within the programmes of study as a whole.

Reading

Pupils should be taught to:

- read and appreciate the depth and power of the English literary heritage through:
  - reading a wide range of high-quality, challenging, classic literature and extended literary non-fiction, such as essays, reviews and journalism. This writing should

include whole texts. The range will include:

- at least one play by Shakespeare
- works from the 19th, 20th and 21st centuries
- poetry since 1789, including representative Romantic poetry

- re-reading literature and other writing as a basis for making comparisons
- choosing and reading books independently for challenge, interest and enjoyment.

- understand and critically evaluate texts through:
  - reading in different ways for different purposes, summarising and synthesising ideas and information, and evaluating their usefulness for particular purposes
  - drawing on knowledge of the purpose, audience for and context of the writing, including its social, historical and cultural context and the literary tradition to which it belongs, to inform evaluation
  - identifying and interpreting themes, ideas and information
  - exploring aspects of plot, characterisation, events and settings, the relationships between them and their effects
  - seeking evidence in the text to support a point of view, including justifying inferences with evidence
  - distinguishing between statements that are supported by evidence and those that are not, and identifying bias and misuse of evidence
  - analysing a writer's choice of vocabulary, form, grammatical and structural features, and evaluating their effectiveness and impact
  - making critical comparisons, referring to the contexts, themes, characterisation, style and literary quality of texts, and drawing on knowledge and skills from wider reading
- make an informed personal response, recognising that other responses to a text are possible and evaluating these.

Writing

Pupils should be taught to:

- write accurately, fluently, effectively and at length for pleasure and information through:
  - adapting their writing for a wide range of purposes and audiences: to describe, narrate, explain, instruct, give and respond to information, and argue
  - selecting and organising ideas, facts and key points, and citing evidence, details and quotation effectively and pertinently for support and emphasis
  - selecting, and using judiciously, vocabulary, grammar, form, and structural and

organisational features, including rhetorical devices, to reflect audience, purpose and context, and using Standard English where appropriate

- make notes, draft and write, including using information provided by others [e.g. writing a letter from key points provided; drawing on and using information from a presentation]
- revise, edit and proof-read through:
    - reflecting on whether their draft achieves the intended impact
    - restructuring their writing, and amending its grammar and vocabulary to improve coherence, consistency, clarity and overall effectiveness
    - paying attention to the accuracy and effectiveness of grammar, punctuation and spelling.[6]

Grammar and vocabulary

Pupils should be taught to:

- consolidate and build on their knowledge of grammar and vocabulary through:
    - studying their effectiveness and impact in the texts they read
    - drawing on new vocabulary and grammatical constructions from their reading and listening, and using these consciously in their writing and speech to achieve particular effects
    - analysing some of the differences between spoken and written language, including differences associated with formal and informal registers, and between Standard English and other varieties of English
    - using linguistic and literary terminology accurately and confidently in discussing reading, writing and spoken language.

[6] Spelling patterns and guidance are set out in Appendix 1 to the key stage 1 and 2 programmes of study for English.

Spoken English

Pupils should be taught to:

- speak confidently, audibly and effectively, including through:
    - using Standard English when the context and audience require it
    - working effectively in groups of different sizes and taking on required roles, including leading and managing discussions, involving others productively, reviewing and summarising, and contributing to meeting goals/deadlines
    - listening to and building on the contributions of others, asking questions to clarify and inform, and challenging courteously when necessary

- planning for different purposes and audiences, including selecting and organising information and ideas effectively and persuasively for formal spoken presentations and debates
- listening and responding in a variety of different contexts, both formal and informal, and evaluating content, viewpoints, evidence and aspects of presentation
- improvising, rehearsing and performing play scripts and poetry in order to generate language and discuss language use and meaning, using role, intonation, tone, volume, mood, silence, stillness and action to add impact.

The following glossary includes all the technical grammatical terms used in the programmes of study for English, as well as others that might be useful. It is intended as an aid for teachers, not as the body of knowledge that should be learnt by pupils. Apart from a few which are used only in schools (for example, *root word*), the terms below are used with the meanings defined here in most modern books on English grammar. It is recognised that there are different schools of thought on grammar, but the terms defined here clarify those being used in the programmes of study. For further details, teachers should consult the many books that are available.

Terms in definitions

As in any tightly structured area of knowledge, grammar, vocabulary and spelling involve a network of technical concepts that help to define each other. Consequently, the definition of one concept builds on other concepts that are equally technical. Concepts that are defined elsewhere in the glossary are hyperlinked. For some concepts, the technical definition may be slightly different from the meaning that some teachers may have learnt at school or may have been using with their own pupils; in these cases, the more familiar meaning is also discussed.

Term	Guidance	Example
active voice	An active verb has its usual pattern of subject and object (in contrast with the passive).	Active: *The school arranged a visit*. Passive: *A visit was arranged* by the school.
adjective	The surest way to identify adjectives is by the ways they can be used: ▪ before a noun, to make the noun's meaning more specific (i.e. to modify the noun), or ▪ after the verb *be*, as its complement. Adjectives cannot be modified by other adjectives. This distinguishes them from nouns, which can be. Adjectives are sometimes called 'describing words' because they pick out single characteristics such as size or colour. This is often true, but it doesn't help to distinguish adjectives from other word classes,	*The pupils did some really good work.* [adjective used before a noun, to modify it] *Their work was good.* [adjective used after the verb *be*, as its complement] Not adjectives: *The lamp glowed.* [verb] *It was such a bright red!* [noun] *He spoke loudly.* [adverb] *It was a French grammar book.* [noun]

Term	Guidance	Example
	because verbs, nouns and adverbs can do the same thing.	

adverb	The surest way to identify adverbs is by the ways they can be used: they can modify a verb, an adjective, another adverb or even a whole clause. Adverbs are sometimes said to describe manner or time. This is often true, but it doesn't help to distinguish adverbs from other word classes that can be used as adverbials, such as preposition phrases, noun phrases and subordinate clauses.	*Usha soon started snoring loudly*. [adverbs modifying the verbs *started* and *snoring*] *That match was really exciting!* [adverb modifying the adjective *exciting*] *We don't get to play games very often*. [adverb modifying the other adverb, *often*] *Fortunately, it didn't rain*. [adverb modifying the whole clause 'it didn't rain' by commenting on it] Not adverbs: ▪ *Usha went up the stairs*. [preposition phrase used as adverbial] ▪ *She finished her work this evening*. [noun phrase used as adverbial] ▪ *She finished when the teacher got cross*. [subordinate clause used as adverbial]
adverbial	An adverbial is a word or phrase that is used, like an adverb, to modify a verb or clause. Of course, adverbs can be used as adverbials, but many other types of words and phrases can be used this way, including preposition phrases and subordinate clauses.	The *bus leaves in five minutes*. [preposition phrase as adverbial: modifies *leaves*] *She promised to see him last night.* [noun phrase modifying either *promised* or *see,* according to the intended meaning] *She worked until she had finished*. [subordinate clause as adverbial]
antonym	Two words are antonyms if their meanings are opposites.	*hot – cold* *light – dark* *light – heavy*
apostrophe	Apostrophes have two completely different uses: ▪ showing the place of missing letters (e.g. *I'm* for *I am*)	*I'm going out and I won't be long*. [showing missing letters] *Hannah's mother went to town in Justin's car*. [marking possessives]

Term	Guidance	Example
	▪ marking possessives (e.g. *Hannah's mother*).	
article	The articles *the* (definite) and *a* or *an* (indefinite) are the most common type of determiner.	*The dog found a bone in an old box.*
auxiliary verb	The auxiliary verbs are: *be, have, do* and the modal verbs. They can be used to make questions and negative statements. In addition: ▪ *be* is used in the progressive and passive ▪ *have* is used in the perfect ▪ *do* is used to form questions and negative statements if no other auxiliary verb is present	*They are winning the match.* [*be* used in the progressive] *Have you finished your picture?* [*have* used to make a question, and the perfect] *No, I don't know him.* [*do* used to make a negative; no other auxiliary is present] *Will you come with me or not?* [modal verb *will* used to make a question about the other person's willingness]
clause	A clause is a special type of phrase whose head is a verb. Clauses can sometimes be complete sentences. Clauses may be main or subordinate. Traditionally, a clause had to have a finite verb, but most modern grammarians also recognise non finite clauses.	*It was raining.* [single-clause sentence] *It was raining but we were indoors.* [two finite clauses] *If you are coming to the party, please let us know.* [finite subordinate clause inside a finite main clause] *Usha went upstairs to play on her computer.* [non-finite clause]
cohesion	A text has cohesion if it is clear how the meanings of its parts fit together. Cohesive devices can help to do this. In the example, there are repeated references to the same thing (shown by the different style pairings), and the logical relations, such as time and cause, between different parts are clear.	**A visit** has been arranged for ***Year 6***, to the Mountain Peaks Field Study Centre, leaving school at 9.30am. **This** is **an overnight visit**. The centre has beautiful grounds and *a nature trail*. During the afternoon, ***the children*** will follow *the trail*.
cohesive device	Cohesive devices are words used to show how the different parts of a text fit together. In other words, they create cohesion.	*Julia's dad bought her a football. The football was expensive!* [determiner; refers us back

		to a particular football]

Term	Guidance	Example
	Some examples of cohesive devices are: ▪ determiners and pronouns, which can refer back to earlier words ▪ conjunctions and adverbs, which can make relations between words clear ▪ ellipsis of expected words.	*Joe was given a bike for Christmas. He liked it very much.* [the pronouns refer back to Joe and the bike] *We'll be going shopping before we go to the park.* [conjunction; makes a relationship of time clear] *I'm afraid we're going to have to wait for the next train. Meanwhile, we could have a cup of tea.* [adverb; refers back to the time of waiting] *Where are you going? [ ] To school!* [ellipsis of the expected words *I'm going*; links the answer back to the question]
complement	A verb's subject complement adds more information about its subject, and its object complement does the same for its object. Unlike the verb's object, its complement may be an adjective. The verb *be* normally has a complement.	*She is our teacher.* [adds more information about the subject, *she*] *They seem very competent.* [adds more information about the subject, *they*] *Learning makes me happy.* [adds more information about the object, *me*]
compound, compounding	A compound word contains at least two root words in its morphology; e.g. *whiteboard, superman*. Compounding is very important in English.	*blackbird, blow-dry, bookshop, ice cream, English teacher, inkjet, one eyed, bone-dry, baby-sit, daydream, outgrow*

conjunction	A conjunction links two words or phrases together. There are two main types of conjunctions: ▪ co-ordinating conjunctions (e.g. *and*) link two words or phrases together as an equal pair ▪ subordinating conjunctions (e.g. *when*) introduce a subordinate clause.	*James bought a bat and ball.* [links the words *bat* and *ball* as an equal pair] *Kylie is young but she can kick the ball hard.* [links two clauses as an equal pair] *Everyone watches when Kyle does back-flips.* [introduces a subordinate clause] *Joe can't practise kicking because he's injured.* [introduces a subordinate clause]

Term	Guidance	Example
consonant	A sound which is produced when the speaker closes off or obstructs the flow of air through the vocal tract, usually using lips, tongue or teeth. Most of the letters of the alphabet represent consonants. Only the letters *a*, *e*, *i*, *o*, *u* and *y* can represent vowel sounds.	/p/ [flow of air stopped by the lips, then released] /t/ [flow of air stopped by the tongue touching the roof of the mouth, then released] /f/ [flow of air obstructed by the bottom lip touching the top teeth] /s/ [flow of air obstructed by the tip of the tongue touching the gum line]
continuous	See progressive	
co-ordinate, co-ordination	Words or phrases are co-ordinated if they are linked as an equal pair by a co-ordinating conjunction (i.e. *and, but, or*). In the examples on the right, the co ordinated elements are shown in bold, and the conjunction is underlined. The difference between co-ordination and subordination is that, in subordination, the two linked elements are not equal.	***Susan** and **Amra** met in a café*. [links the words *Susan* and *Amra* as an equal pair] ***They talked** and **drank tea** for an hour.* [links two clauses as an equal pair] ***Susan got a bus** but **Amra walked***. [links two clauses as an equal pair] Not co-ordination: *They ate before they met*. [*before* introduces a subordinate clause]

determiner	A determiner specifies a noun as known or unknown, and it goes before any modifiers (e.g. adjectives or other nouns). Some examples of determiners are: ▪ articles (*the*, *a* or *an*) ▪ demonstratives (e.g. *this*, *those*) ▪ possessives (e.g. *my*, *your*) ▪ quantifiers (e.g. *some*, *every*).	*the home team* [article, specifies the team as known] *a good team* [article, specifies the team as unknown] *that pupil* [demonstrative, known] *Julia's parents* [possessive, known] *some big boys* [quantifier, unknown] Contrast: *home the team, big some boys* [both incorrect, because the determiner should come before other modifiers]
digraph	A type of grapheme where two letters represent one phoneme. Sometimes, these two letters are not next to one another; this is called a	The digraph *ea* in *each* is pronounced /i:/. The digraph *sh* in *shed* is pronounced /ʃ/.

Term	Guidance	Example
	split digraph.	The split digraph *i–e* in *line* is pronounced /aɪ/.
ellipsis	Ellipsis is the omission of a word or phrase which is expected and predictable.	*Frankie waved to Ivana and ~~she~~ watched her drive away.* *She did it because she wanted to ~~do it~~.*
etymology	A word's etymology is its history: its origins in earlier forms of English or other languages, and how its form and meaning have changed. Many words in English have come from Greek, Latin or French.	The word *school* was borrowed from a Greek word *ó÷ïëÞ* (*skholé*) meaning 'leisure'. The word *verb* comes from Latin *verbum*, meaning 'word'. The word *mutton* comes from French *mouton*, meaning 'sheep'.

finite verb	Every sentence typically has at least one verb which is either past or present tense. Such verbs are called 'finite'. The imperative verb in a command is also finite. Verbs that are not finite, such as participles or infinitives, cannot stand on their own: they are linked to another verb in the sentence.	*Lizzie does the dishes every day.* [present tense] *Even Hana did the dishes yesterday.* [past tense] *Do the dishes, Naser!* [imperative] Not finite verbs: ▪ *I have done them.* [combined with the finite verb *have*] ▪ *I will do them.* [combined with the finite verb *will*] ▪ *I want to do them!* [combined with the finite verb *want*]
fronting, fronted	A word or phrase that normally comes after the verb may be moved before the verb: when this happens, we say it has been 'fronted'. For example, a fronted adverbial is an adverbial which has been moved before the verb. When writing fronted phrases, we often follow them with a comma.	*Before we begin, make sure you've got a pencil.* [Without fronting: *Make sure you've got a pencil before we begin.*] *The day after tomorrow, I'm visiting my granddad.* [Without fronting: *I'm visiting my granddad the day after tomorrow.*]
future	Reference to future time can be marked in a number of different ways in English. All these ways involve the use of a present-tense verb. See also tense. Unlike many other languages (such	*He will leave tomorrow.* [present tense *will* followed by infinitive *leave*] *He may leave tomorrow.* [present tense *may* followed by infinitive *leave*]

Term	Guidance	Example
	as French, Spanish or Italian), English has no distinct 'future tense' form of the verb comparable with its present and past tenses.	*He leaves tomorrow.* [present tense *leaves*] *He is going to leave tomorrow.* [present tense *is* followed by *going to* plus the infinitive *leave*]
GPC	See grapheme-phoneme correspondences.	

grapheme	A letter, or combination of letters, that corresponds to a single phoneme within a word.	The grapheme *t* in the words *ten*, *bet* and *ate* corresponds to the phoneme /t/. The grapheme *ph* in the word *dolphin* corresponds to the phoneme /f/.
grapheme phoneme correspondences	The links between letters, or combinations of letters (graphemes) and the speech sounds (phonemes) that they represent. In the English writing system, graphemes may correspond to different phonemes in different words.	The grapheme *s* corresponds to the phoneme /s/ in the word *see*, but… …it corresponds to the phoneme /z/ in the word *easy*.
head	See phrase.	
homonym	Two different words are homonyms if they both look exactly the same when written, and sound exactly the same when pronounced.	*Has he left yet? Yes – he went through the door on the left.* *The noise a dog makes is called a bark. Trees have bark.*
homophone	Two different words are homophones if they sound exactly the same when pronounced.	*hear*, *here* *some*, *sum*
infinitive	A verb's infinitive is the basic form used as the head-word in a dictionary (e.g. *walk, be*). Infinitives are often used: ▪ after *to* ▪ after modal verbs.	*I want to walk.* *I will be quiet.*
inflection	When we add *-ed* to *walk*, or change *mouse* to *mice*, this change of morphology produces an inflection ('bending') of the basic word which has special grammar (e.g. past tense	*dogs* is an inflection of *dog.* *went* is an inflection of *go.* *better* is an inflection of *good*.

Term	Guidance	Example

	or plural). In contrast, adding *-er* to *walk* produces a completely different word, *walker*, which is part of the same word family. Inflection is sometimes thought of as merely a change of ending, but, in fact, some words change completely when inflected.	
intransitive verb	A verb which does not need an object in a sentence to complete its meaning is described as intransitive. See 'transitive verb'.	*We all laughed.* *We would like to stay longer, but we must leave.*
main clause	A sentence contains at least one clause which is not a subordinate clause; such a clause is a main clause. A main clause may contain any number of subordinate clauses.	*It was raining but the sun was shining*. [two main clauses] *The man **who wrote it** told me **that it was true***. [one main clause containing two subordinate clauses.] *She said, "It rained all day."* [one main clause containing another.]
modal verb	Modal verbs are used to change the meaning of other verbs. They can express meanings such as certainty, ability, or obligation. The main modal verbs are *will, would, can, could, may, might, shall, should, must* and *ought*. A modal verb only has finite forms and has no suffixes (e.g. *I sing – he sings*, but not *I must – he musts*).	*I can do this maths work by myself. This ride may be too scary for you! You should help your little brother.* *Is it going to rain? Yes, it might.* *Canning swim is important*. [not possible because *can* must be finite; contrast: *Being able to swim is important*, where *being* is not a modal verb]
modify, modifier	One word or phrase modifies another by making its meaning more specific. Because the two words make a phrase, the 'modifier' is normally close to the modified word.	In the phrase *primary-school teacher*: ▪ *teacher* is modified by *primary school* (to mean a specific kind of teacher) ▪ *school* is modified by *primary* (to mean a specific kind of school).

morphology	A word's morphology is its internal make-up in terms of root words and suffixes or prefixes, as well as other kinds of change such as the change	*dogs* has the morphological make up: *dog* + *s.* *unhelpfulness* has the

Term	Guidance	Example
	of *mouse* to *mice*. Morphology may be used to produce different inflections of the same word (e.g. *boy* – *boys*), or entirely new words (e.g. *boy* – *boyish*) belonging to the same word family. A word that contains two or more root words is a compound (e.g. *news+paper, ice+cream*).	morphological make-up: *unhelpful* + *ness* ▪ where *unhelpful* = *un* + *helpful* ▪ and *helpful* = *help* + *ful*
noun	The surest way to identify nouns is by the ways they can be used after determiners such as *the*: for example, most nouns will fit into the frame "The matters/matter." Nouns are sometimes called 'naming words' because they name people, places and 'things'; this is often true, but it doesn't help to distinguish nouns from other word classes. For example, prepositions can name places and verbs can name 'things' such as actions. Nouns may be classified as **common** (e.g. *boy, day*) or **proper** (e.g. *Ivan*, *Wednesday*), and also as **countable** (e.g. *thing, boy*) or **non countable** (e.g. *stuff, money*). These classes can be recognised by the determiners they combine with.	*Our dog bit the burglar on his behind!* *My big brother did an amazing jump on his skateboard.* *Actions speak louder than words*. Not nouns: ▪ *He's behind you!* [this names a place, but is a preposition, not a noun] ▪ *She can jump so high!* [this names an action, but is a verb, not a noun] common, countable: *a book, books, two chocolates, one day, fewer ideas* common, non-countable: *money, some chocolate, less imagination* proper, countable: *Marilyn, London, Wednesday*

noun phrase	A noun phrase is a phrase with a noun as its head, e.g. *some foxes*, *foxes with bushy tails*. Some grammarians recognise one-word phrases, so that *foxes are multiplying* would contain the noun *foxes* acting as the head of the noun phrase *foxes*.	*Adult foxes can jump.* [*adult* modifies *foxes*, so *adult* belongs to the noun phrase] *Almost all healthy adult foxes in this area can jump.* [all the other words help to modify *foxes*, so they all belong to the noun phrase]
object	An object is normally a noun, pronoun or noun phrase that comes straight after the verb, and shows what the verb is acting upon. Objects can be turned into the	*Year 2 designed puppets.* [noun acting as object] *I like that.* [pronoun acting as object]

Term	Guidance	Example
	subject of a passive verb, and cannot be adjectives (contrast with complements).	Some people suggested a pretty display. [noun phrase acting as object] Contrast: ▪ *A display was suggested*. [object of active verb becomes the subject of the passive verb] ▪ *Year 2 designed pretty*. [incorrect, because adjectives cannot be objects]
participle	Verbs in English have two participles, called 'present participle' (e.g. *walking, taking*) and 'past participle' (e.g. *walked, taken*). Unfortunately, these terms can be confusing to learners, because: ▪ they don't necessarily have anything to do with present or past time ▪ although past participles are used as perfects (e.g. *has eaten*) they are also used as passives (e.g. *was eaten*).	*He is walking to school*. [present participle in a progressive] *He has taken the bus to school*. [past participle in a perfect] *The photo was taken in the rain.* [past participle in a passive]

passive	The sentence *It was eaten by our dog* is the passive of *Our dog ate it*. A passive is recognisable from: ▪ the past participle form *eaten* ▪ the normal object (*it*) turned into the subject ▪ the normal subject (*our dog*) turned into an optional preposition phrase with *by* as its head ▪ the verb *be*(*was*), or some other verb such as *get*. Contrast active. A verb is not 'passive' just because it has a passive meaning: it must be the passive version of an active verb.	*A visit was arranged by the school. Our cat got run over by a bus.* Active versions: ▪ *The school arranged a visit.* ▪ *A bus ran over our cat.* Not passive: ▪ *He received a warning.* [past tense, active *received*] ▪ *We had an accident.* [past tense, active *had*]
past tense	Verbs in the past tense are commonly used to:	*Tom and Chris showed me their new TV*. [names an event in the

Term	Guidance	Example
	▪ talk about the past ▪ talk about imagined situations ▪ make a request sound more polite. Most verbs take a suffix –*ed*, to form their past tense, but many commonly-used verbs are irregular. See also tense.	past] *Antonio went on holiday to Brazil*. [names an event in the past; irregular past of *go*] *I wish I had a puppy.* [names an imagined situation, not a situation in the past] *I was hoping you'd help tomorrow.* [makes an implied request sound more polite]

perfect	The perfect form of a verb generally calls attention to the consequences of a prior event; for example, *he has gone to lunch* implies that he is still away, in contrast with *he went to lunch*. 'Had gone to lunch' takes a past time point (i.e. when we arrived) as its reference point and is another way of establishing time relations in a text. The perfect tense is formed by: ▪ turning the verb into its past participle inflection ▪ adding a form of the verb *have* before it. It can also be combined with the progressive (e.g. *he has been going*).	*She has downloaded some songs.* [present perfect; now she has some songs] *I had eaten lunch when you came.* [past perfect; I wasn't hungry when you came]
phoneme	A phoneme is the smallest unit of sound that signals a distinct, contrasting meaning. For example: ▪ /t/ contrasts with /k/ to signal the difference between *tap* and *cap* ▪ /t/ contrasts with /l/ to signal the difference between *bought* and *ball*. It is this contrast in meaning that tells us there are two distinct phonemes at work. There are around 44 phonemes in English; the exact number depends on regional accents. A single	The word *cat* has three letters and three phonemes: /kæt/ The word *catch* has five letters and three phonemes: /katʃ/ The word *caught* has six letters and three phonemes: /kɔ:t/

Term	Guidance	Example
	phoneme may be represented in writing by one, two, three or four letters constituting a single grapheme.	

phrase	A phrase is a group of words that are grammatically connected so that they stay together, and that expand a single word, called the 'head'. The phrase is a noun phrase if its head is a noun, a preposition phrase if its head is a preposition, and so on; but if the head is a verb, the phrase is called a clause. Phrases can be made up of other phrases.	*She waved to her mother.* [a noun phrase, with the noun *mother* as its head] *She waved to her mother.* [a preposition phrase, with the preposition *to* as its head] *She waved to her mother.* [a clause, with the verb *waved* as its head]
plural	A plural noun normally has a suffix – *s* or –es and means 'more than one'. There are a few nouns with different morphology in the plural (e.g. *mice, formulae*).	*dogs* [more than one dog]; *boxes* [more than one box] *mice* [more than one mouse]
possessive	A possessive can be: ▪ a noun followed by an apostrophe, with or without *s* ▪ a possessive pronoun. The relation expressed by a possessive goes well beyond ordinary ideas of 'possession'. A possessive may act as a determiner.	*Tariq's book* [Tariq has the book] *The boys' arrival* [the boys arrive] *His obituary* [the obituary is about him] *That essay is mine*. [I wrote the essay]
prefix	A prefix is added at the beginning of a word in order to turn it into another word. Contrast suffix.	*overtake, disappear*
preposition	A preposition links a following noun, pronoun or noun phrase to some other word in the sentence. Prepositions often describe locations or directions, but can describe other things, such as relations of time. Words like *before* or *since* can act either as prepositions or as conjunctions.	*Tom waved goodbye to Christy. She'll be back from Australia in two weeks.* *I haven't seen my dog since this morning.* Contrast: *I'm going, since no-one wants me here!* [conjunction: links two clauses]

Term	Guidance	Example

preposition phrase	A preposition phrase has a preposition as its head followed by a noun, pronoun or noun phrase.	*He was in bed.* *I met them after the party.*
present tense	Verbs in the present tense are commonly used to: ▪ talk about the present ▪ talk about the future. They may take a suffix *–s* (depending on the subject). See also tense.	*Jamal goes to the pool every day.* [describes a habit that exists now] *He can swim.* [describes a state that is true now] *The bus arrives at three.* [scheduled now] *My friends are coming to play*. [describes a plan in progress now]
progressive	The progressive (also known as the 'continuous') form of a verb generally describes events in progress. It is formed by combining the verb's present participle (e.g. *singing*) with a form of the verb *be* (e.g. *he was singing*). The progressive can also be combined with the perfect (e.g. *he has been singing*).	*Michael is singing in the store room.* [present progressive] *Amanda was making a patchwork quilt.* [past progressive] *Usha had been practising for an hour when I called.* [past perfect progressive]
pronoun	Pronouns are normally used like nouns, except that: ▪ they are grammatically more specialised ▪ it is harder to modify them In the examples, each sentence is written twice: once with nouns, and once with pronouns (underlined). Where the same thing is being talked about, the words are shown in bold.	***Amanda** waved to **Michael**.* ***She** waved to **him**.* ***John's** mother is over there.* ***His** mother is over there.* *The **visit** will be an overnight **visit**. **This** will be an overnight **visit**.* ***Simon** is the person: **Simon** broke it. **He** is the one **who** broke it.*
punctuation	Punctuation includes any conventional features of writing other than spelling and general layout: the standard punctuation marks . , ; : ? ! - – ( ) " " ' ' , and also word-spaces, capital letters, apostrophes, paragraph breaks and bullet points. One important role of punctuation is to indicate sentence boundaries.	*"I'm going out, Usha, and I won't be long," Mum said.*

Received Pronunciation	Received Pronunciation (often abbreviated to RP) is an accent which is used only by a small	

Term	Guidance	Example
	minority of English speakers in England. It is not associated with any one region. Because of its regional neutrality, it is the accent which is generally shown in dictionaries in the UK (but not, of course, in the USA). RP has no special status in the national curriculum.	
register	Classroom lessons, football commentaries and novels use different registers of the same language, recognised by differences of vocabulary and grammar. Registers are 'varieties' of a language which are each tied to a range of uses, in contrast with dialects, which are tied to groups of users.	*I regret to inform you that Mr Joseph Smith has passed away.* [formal letter] *Have you heard that Joe has died?* [casual speech] *Joe falls down and dies, centre stage.* [stage direction]
relative clause	A relative clause is a special type of subordinate clause that modifies a noun. It often does this by using a relative pronoun such as *who* or *that* to refer back to that noun, though the relative pronoun *that* is often omitted. A relative clause may also be attached to a clause. In that case, the pronoun refers back to the whole clause, rather than referring back to a noun. In the examples, the relative clauses are underlined, and both the pronouns and the words they refer back to are in bold.	*That's the **boy** **who** lives near school.* [*who* refers back to *boy*] *The **prize** **that** I won was a book.* [*that* refers back to *prize*] *The **prize** I won was a book.* [the pronoun *that* is omitted] ***Tom broke the game**, **which** annoyed Ali.* [*which* refers back to the whole clause]

root word	Morphology breaks words down into root words, which can stand alone, and suffixes or prefixes which can't. For example, *help* is the root word for other words in its word family such as *helpful* and *helpless*, and also for its inflections such as *helping*. Compound words (e.g. *help desk*) contain two or more root words. When looking in a dictionary, we sometimes have to look for the	*played* [the root word is *play*] *unfair* [the root word is *fair*] *football* [the root words are *foot* and *ball*]

Term	Guidance	Example
	root word (or words) of the word we are interested in.	
schwa	The name of a vowel sound that is found only in unstressed positions in English. It is the most common vowel sound in English. It is written as /ə/ in the International Phonetic Alphabet. In the English writing system, it can be written in many different ways.	/əlɒŋ/ [*along*] /bʌtə/ [*butter*] /dɒktə/ [*doctor*]

sentence	A sentence is a group of words which are grammatically connected to each other but not to any words outside the sentence. The form of a sentence's main clause shows whether it is being used as a statement, a question, a command or an exclamation. A sentence may consist of a single clause or it may contain several clauses held together by subordination or co-ordination. Classifying sentences as 'simple', 'complex' or 'compound' can be confusing, because a 'simple' sentence may be complicated, and a 'complex' one may be straightforward. The terms **'single clause sentence**' and **'multi-clause sentence**' may be more helpful.	*John went to his friend's house. He stayed there till tea-time.* *John went to his friend's house, he stayed there till tea-time.* [This is a 'comma splice', a common error in which a comma is used where either a full stop or a semi-colon is needed to indicate the lack of any grammatical connection between the two clauses.] *You are my friend.* [statement] *Are you my friend?* [question] *Be my friend!* [command] *What a good friend you are!* [exclamation] *Ali went home on his bike to his goldfish and his current library book about pets.* [single-clause sentence] *She went shopping but took back everything she had bought because she didn't like any of it.* [multi-clause sentence]
split digraph	See digraph.	
Standard English	Standard English can be recognised by the use of a very small range of forms such as *those books, I did it* and *I wasn't doing anything* (rather than their non-Standard equivalents); it is not limited to any particular accent. It is the variety of English which is used, with only minor	*I did it because they were not willing to undertake any more work on those houses.* [formal Standard English] *I did it cos they wouldn't do any more work on those houses.* [casual Standard English]

Term	Guidance	Example

	variation, as a major world language. Some people use Standard English all the time, in all situations from the most casual to the most formal, so it covers most registers. The aim of the national curriculum is that everyone should be able to use Standard English as needed in writing and in relatively formal speaking.	*I done it cos they wouldn't do no more work on them houses.* [casual non-Standard English]
stress	A syllable is stressed if it is pronounced more forcefully than the syllables next to it. The other syllables are unstressed.	*about* *visit*
subject	The subject of a verb is normally the noun, noun phrase or pronoun that names the 'do-er' or 'be-er'. The subject's normal position is: ▪ just before the verb in a statement ▪ just after the auxiliary verb, in a question. Unlike the verb's object and complement, the subject can determine the form of the verb (e.g. *I am*, *you are*).	*Rula's mother went out.* *That is uncertain.* *The children will study the animals. Will the children study the animals?*
subjunctive	In some languages, the inflections of a verb include a large range of special forms which are used typically in subordinate clauses, and are called 'subjunctives'. English has very few such forms and those it has tend to be used in rather formal styles.	*The school requires that all pupils be honest.* *The school rules demand that pupils not enter the gym at lunchtime.* *If Zoë were the class president, things would be much better.*
subordinate, subordination	A subordinate word or phrase tells us more about the meaning of the word it is subordinate to. Subordination can be thought of as an unequal relationship between a subordinate word and a main word. For example: ▪ an adjective is subordinate to the noun it modifies	*big dogs* [*big* is subordinate to *dogs*] *Big dogs need long walks.* [*big dogs* and *long walks* are subordinate to *need*] *We can watch TV when we've finished.* [*when we've finished* is subordinate to *watch*]

	▪ subjects and objects are	

Term	Guidance	Example
	subordinate to their verbs. Subordination is much more common than the equal relationship of co-ordination. See also subordinate clause.	
subordinate clause	A clause which is subordinate to some other part of the same sentence is a subordinate clause; for example, in *The apple that I ate was sour*, the clause *that I ate* is subordinate to *apple* (which it modifies). Subordinate clauses contrast with co-ordinate clauses as in *It was sour but looked very tasty*. (Contrast: main clause) However, clauses that are directly quoted as direct speech are not subordinate clauses.	*That's the street where Ben lives.* [relative clause; modifies *street*] *He watched her as she disappeared*. [adverbial; modifies *watched*] *What you said was very nice.* [acts as subject of *was*] *She noticed an hour had passed.* [acts as object of *noticed*] Not subordinate: *He shouted, "Look out!"*
suffix	A suffix is an 'ending', used at the end of one word to turn it into another word. Unlike root words, suffixes cannot stand on their own as a complete word. Contrast prefix.	*call – called* *teach – teacher* [turns a verb into a noun] *terror – terrorise* [turns a noun into a verb] *green – greenish* [leaves word class unchanged]
syllable	A syllable sounds like a beat in a word. Syllables consist of at least one vowel, and possibly one or more consonants.	*Cat* has one syllable. *Fairy* has two syllables. *Hippopotamus* has five syllables.
synonym	Two words are synonyms if they have the same meaning, or similar meanings. Contrast antonym.	*talk – speak* *old – elderly*

tense	In English, tense is the choice between present and past verbs, which is special because it is signalled by inflections and normally indicates differences of time. In contrast, languages like French, Spanish and Italian, have three or more distinct tense forms, including	*He studies*. [present tense – present time] *He studied yesterday*. [past tense – past time] *He studies tomorrow, or else!* [present tense – future time] *He may study tomorrow*. [present

Term	Guidance	Example
	a future tense. (See also: future.) The simple tenses (present and past) may be combined in English with the perfect and progressive.	tense + infinitive – future time] *He plans to study tomorrow*. [present tense + infinitive – future time] *If he studied tomorrow, he'd see the difference!* [past tense – imagined future] Contrast three distinct tense forms in Spanish: ▪ *Estudia.* [present tense] ▪ *Estudió.* [past tense] ▪ *Estudiará.* [future tense]
transitive verb	A transitive verb takes at least one object in a sentence to complete its meaning, in contrast to an intransitive verb, which does not.	*He loves Juliet.* *She understands English grammar.*
trigraph	A type of grapheme where three letters represent one phoneme.	*High, pure, patch, hedge*
unstressed	See stressed.	

verb	The surest way to identify verbs is by the ways they can be used: they can usually have a tense, either present or past (see also future). Verbs are sometimes called 'doing words' because many verbs name an action that someone does; while this can be a way of recognising verbs, it doesn't distinguish verbs from nouns (which can also name actions). Moreover many verbs name states or feelings rather than actions. Verbs can be classified in various ways: for example, as auxiliary, or modal; as transitive or intransitive; and as states or events.	*He lives in Birmingham.* [present tense] *The teacher wrote a song for the class.* [past tense] *He likes chocolate.* [present tense; not an action] *He knew my father.* [past tense; not an action] Not verbs: ▪ *The walk to Halina's house will take an hour.* [noun] ▪ *All that surfing makes Morwenna so sleepy!* [noun]
vowel	A vowel is a speech sound which is produced without any closure or obstruction of the vocal tract. Vowels can form syllables by themselves, or they may combine with consonants. In the English writing system, the letters *a*, *e*, *i*, *o*, *u* and *y* can represent vowels.	

Term	Guidance	Example
word	A word is a unit of grammar: it can be selected and moved around relatively independently, but cannot easily be split. In punctuation, words are normally separated by word spaces. Sometimes, a sequence that appears grammatically to be two words is collapsed into a single written word, indicated with a hyphen or apostrophe (e.g. *well-built, he's*).	*headteacher* or *head teacher* [can be written with or without a space] *I'm* going out. *9.30 am*

word class	Every word belongs to a word class which summarises the ways in which it can be used in grammar. The major word classes for English are: noun, verb, adjective, adverb, preposition, determiner, pronoun, conjunction. Word classes are sometimes called 'parts of speech'.	
word family	The words in a word family are normally related to each other by a combination of morphology, grammar and meaning.	*teach – teacher* *extend – extent – extensive* *grammar – grammatical – grammarian*

Mathematics

Purpose of study

Mathematics is a creative and highly inter-connected discipline that has been developed over centuries, providing the solution to some of history's most intriguing problems. It is essential to everyday life, critical to science, technology and engineering, and necessary for financial literacy and most forms of employment. A high-quality mathematics education therefore provides a foundation for understanding the world, the ability to reason mathematically, an appreciation of the beauty and power of mathematics, and a sense of enjoyment and curiosity about the subject.

Aims

The national curriculum for mathematics aims to ensure that all pupils:

- become **fluent** in the fundamentals of mathematics, including through varied and frequent practice with increasingly complex problems over time, so that pupils develop conceptual understanding and the ability to recall and apply knowledge rapidly and accurately.
- **reason mathematically** by following a line of enquiry, conjecturing relationships and generalisations, and developing an argument, justification or proof using mathematical language
- can **solve problems** by applying their mathematics to a variety of routine and non routine problems with increasing sophistication, including breaking down problems into a series of simpler steps and persevering in seeking solutions.

Information and communication technology (ICT)

Calculators should not be used as a substitute for good written and mental arithmetic. In secondary schools, teachers should use their judgement about when ICT tools should be used.

Spoken language

The national curriculum for mathematics reflects the importance of spoken language in pupils' development across the whole curriculum – cognitively, socially and linguistically. The quality and variety of language that pupils hear and speak are key factors in developing their mathematical vocabulary and presenting a mathematical justification, argument or proof. They must be assisted in making their thinking clear to themselves as well as others and teachers should ensure that pupils build secure foundations by using discussion to probe and remedy their misconceptions.

Schools are not required by law to teach the example content in [square brackets] or the content indicated as being 'non-statutory'.

Introduction

Mathematics is an interconnected subject in which pupils need to be able to move fluently between representations of mathematical ideas. The programme of study for key stage 3 is organised into apparently distinct domains, but pupils should build on key stage 2 and connections across mathematical ideas to develop fluency, mathematical reasoning and competence in solving increasingly sophisticated problems. They should also apply their mathematical knowledge in science, geography, computing and other subjects.

The expectation is that the majority of pupils will move through the programme of study at broadly the same pace. However, decisions about when to progress should always be based on the security of pupils' understanding and their readiness to progress. Pupils who grasp concepts rapidly should be challenged through being offered rich and sophisticated problems before any acceleration through new content in preparation for key stage 4. Those who are not sufficiently fluent should consolidate their understanding, including through additional practice, before moving on.

Attainment targets

By the end of key stage 3, pupils are expected to know, apply and understand the matters, skills and processes specified in the relevant programme of study.

Working mathematically

Through the mathematics content, pupils should be taught to:

Develop fluency

- consolidate their numerical and mathematical capability from key stage 2 and extend their understanding of the number system and place value to include decimals, fractions, powers and roots
- select and use appropriate calculation strategies to solve increasingly complex problems
- use algebra to generalise the structure of arithmetic, including to formulate mathematical relationships
- substitute values in expressions, rearrange and simplify expressions, and solve equations
- move freely between different numerical, algebraic, graphical and diagrammatic representations [for example, equivalent fractions, fractions and decimals, and equations and graphs]
- develop algebraic and graphical fluency, including understanding linear and simple quadratic functions

- use language and properties precisely to analyse numbers, algebraic expressions, 2-D and 3-D shapes, probability and statistics.

Reason mathematically

- extend their understanding of the number system; make connections between number relationships, and their algebraic and graphical representations
- extend and formalise their knowledge of ratio and proportion in working with measures and geometry, and in formulating proportional relations algebraically
- identify variables and express relations between variables algebraically and graphically
- make and test conjectures about patterns and relationships; look for proofs or counter examples
- begin to reason deductively in geometry, number and algebra, including using geometrical constructions
- interpret when the structure of a numerical problem requires additive, multiplicative or proportional reasoning
- explore what can and cannot be inferred in statistical and probabilistic settings, and begin to express their arguments formally.

Solve problems

- develop their mathematical knowledge, in part through solving problems and evaluating the outcomes, including multi-step problems
- develop their use of formal mathematical knowledge to interpret and solve problems, including in financial mathematics
- begin to model situations mathematically and express the results using a range of formal mathematical representations
- select appropriate concepts, methods and techniques to apply to unfamiliar and non routine problems.

Subject content

Number

Pupils should be taught to:

- understand and use place value for decimals, measures and integers of any size
- order positive and negative integers, decimals and fractions; use the number line as a model for ordering of the real numbers; use the symbols =, ≠, <, >, ≤, ≥
- use the concepts and vocabulary of prime numbers, factors (or divisors), multiples, common factors, common multiples, highest common factor, lowest common multiple, prime factorisation, including using product notation and the unique factorisation property

- use the four operations, including formal written methods, applied to integers, decimals, proper and improper fractions, and mixed numbers, all both positive and negative

- use conventional notation for the priority of operations, including brackets, powers, roots and reciprocals
- recognise and use relationships between operations including inverse operations
- use integer powers and associated real roots (square, cube and higher), recognise powers of 2, 3, 4, 5 and distinguish between exact representations of roots and their decimal approximations
- interpret and compare numbers in standard form A x 10^n 1≤A<10, where n is a positive or negative integer or zero
- work interchangeably with terminating decimals and their corresponding fractions (such as 3.5 and $\frac{7}{2}$ or 0.375 and $\frac{3}{8}$)
- define percentage as 'number of parts per hundred', interpret percentages and percentage changes as a fraction or a decimal, interpret these multiplicatively, express one quantity as a percentage of another, compare two quantities using percentages, and work with percentages greater than 100%
- interpret fractions and percentages as operators
- use standard units of mass, length, time, money and other measures, including with decimal quantities
- round numbers and measures to an appropriate degree of accuracy [for example, to a number of decimal places or significant figures]
- use approximation through rounding to estimate answers and calculate possible resulting errors expressed using inequality notation $a<x\leq b$
- use a calculator and other technologies to calculate results accurately and then interpret them appropriately
- appreciate the infinite nature of the sets of integers, real and rational numbers.

Algebra

Pupils should be taught to:

- use and interpret algebraic notation, including:
  - ab in place of $a \times b$
  - $3y$ in place of $y + y + y$ and $3 \times y$
  - a^2 in place of $a \times a$, a^3 in place of $a \times a \times a$; a^2b in place of $a \times a \times b$
  - $\frac{a}{b}$ in place of $a \div b$
  - coefficients written as fractions rather than as decimals
  - brackets
- substitute numerical values into formulae and expressions, including scientific formulae

- understand and use the concepts and vocabulary of expressions, equations, inequalities, terms and factors
- simplify and manipulate algebraic expressions to maintain equivalence by:

    - collecting like terms
    - multiplying a single term over a bracket
    - taking out common factors
    - expanding products of two or more binomials
- understand and use standard mathematical formulae; rearrange formulae to change the subject
- model situations or procedures by translating them into algebraic expressions or formulae and by using graphs
- use algebraic methods to solve linear equations in one variable (including all forms that require rearrangement)
- work with coordinates in all four quadrants
- recognise, sketch and produce graphs of linear and quadratic functions of one variable with appropriate scaling, using equations in x and y and the Cartesian plane
- interpret mathematical relationships both algebraically and graphically
- reduce a given linear equation in two variables to the standard form $y = mx + c$; calculate and interpret gradients and intercepts of graphs of such linear equations numerically, graphically and algebraically
- use linear and quadratic graphs to estimate values of y for given values of x and vice versa and to find approximate solutions of simultaneous linear equations
- find approximate solutions to contextual problems from given graphs of a variety of functions, including piece-wise linear, exponential and reciprocal graphs
- generate terms of a sequence from either a term-to-term or a position-to-term rule
- recognise arithmetic sequences and find the nth term
- recognise geometric sequences and appreciate other sequences that arise.

Ratio, proportion and rates of change

Pupils should be taught to:

- change freely between related standard units [for example time, length, area, volume/capacity, mass]
- use scale factors, scale diagrams and maps
- express one quantity as a fraction of another, where the fraction is less than 1 and greater than 1
- use ratio notation, including reduction to simplest form

- divide a given quantity into two parts in a given part:part or part:whole ratio; express the division of a quantity into two parts as a ratio
- understand that a multiplicative relationship between two quantities can be expressed

as a ratio or a fraction

- relate the language of ratios and the associated calculations to the arithmetic of fractions and to linear functions
- solve problems involving percentage change, including: percentage increase, decrease and original value problems and simple interest in financial mathematics
- solve problems involving direct and inverse proportion, including graphical and algebraic representations
- use compound units such as speed, unit pricing and density to solve problems.

Geometry and measures

Pupils should be taught to:

- derive and apply formulae to calculate and solve problems involving: perimeter and area of triangles, parallelograms, trapezia, volume of cuboids (including cubes) and other prisms (including cylinders)
- calculate and solve problems involving: perimeters of 2-D shapes (including circles), areas of circles and composite shapes
- draw and measure line segments and angles in geometric figures, including interpreting scale drawings
- derive and use the standard ruler and compass constructions (perpendicular bisector of a line segment, constructing a perpendicular to a given line from/at a given point, bisecting a given angle); recognise and use the perpendicular distance from a point to a line as the shortest distance to the line
- describe, sketch and draw using conventional terms and notations: points, lines, parallel lines, perpendicular lines, right angles, regular polygons, and other polygons that are reflectively and rotationally symmetric
- use the standard conventions for labelling the sides and angles of triangle ABC, and know and use the criteria for congruence of triangles
- derive and illustrate properties of triangles, quadrilaterals, circles, and other plane figures [for example, equal lengths and angles] using appropriate language and technologies
- identify properties of, and describe the results of, translations, rotations and reflections applied to given figures
- identify and construct congruent triangles, and construct similar shapes by enlargement, with and without coordinate grids
- apply the properties of angles at a point, angles at a point on a straight line, vertically opposite angles
- understand and use the relationship between parallel lines and alternate and corresponding angles

- derive and use the sum of angles in a triangle and use it to deduce the angle sum in any polygon, and to derive properties of regular polygons
- apply angle facts, triangle congruence, similarity and properties of quadrilaterals to derive results about angles and sides, including Pythagoras' Theorem, and use

known results to obtain simple proofs
- use Pythagoras' Theorem and trigonometric ratios in similar triangles to solve problems involving right-angled triangles
- use the properties of faces, surfaces, edges and vertices of cubes, cuboids, prisms, cylinders, pyramids, cones and spheres to solve problems in 3-D
- interpret mathematical relationships both algebraically and geometrically.

Probability

Pupils should be taught to:

- record, describe and analyse the frequency of outcomes of simple probability experiments involving randomness, fairness, equally and unequally likely outcomes, using appropriate language and the 0-1 probability scale
- understand that the probabilities of all possible outcomes sum to 1
- enumerate sets and unions/intersections of sets systematically, using tables, grids and Venn diagrams
- generate theoretical sample spaces for single and combined events with equally likely, mutually exclusive outcomes and use these to calculate theoretical probabilities.

Statistics

Pupils should be taught to:

- describe, interpret and compare observed distributions of a single variable through: appropriate graphical representation involving discrete, continuous and grouped data; and appropriate measures of central tendency (mean, mode, median) and spread (range, consideration of outliers)
- construct and interpret appropriate tables, charts, and diagrams, including frequency tables, bar charts, pie charts, and pictograms for categorical data, and vertical line (or bar) charts for ungrouped and grouped numerical data
- describe simple mathematical relationships between two variables (bivariate data) in observational and experimental contexts and illustrate using scatter graphs.

Introduction

Mathematics is an interconnected subject in which pupils need to be able to move fluently between representations of mathematical ideas. The programme of study for key stage 4 is organised into apparently distinct domains, but pupils should develop and consolidate connections across mathematical ideas. They should build on learning from key stage 3 to further develop fluency, mathematical reasoning and competence in solving increasingly sophisticated problems. They should also apply their mathematical knowledge wherever relevant in other subjects and in financial contexts.

The expectation is that the majority of pupils will move through the programme of study at broadly the same pace. However, decisions about when to progress should always be based on the security of pupils' understanding and their readiness to progress. Pupils who grasp concepts rapidly should be challenged through being offered rich and sophisticated problems before any acceleration through new content. Those who are not sufficiently fluent with earlier material should consolidate their understanding, including through additional practice, before moving on.

This programme of study specifies:

- the mathematical content that should be taught to all pupils, in standard type; and
- additional mathematical content to be taught to more highly attaining pupils, in **bold** type and braces { }.

Together, the mathematical content set out in the key stage 3 and key stage 4 programmes of study covers the full range of material contained in the GCSE Mathematics qualification. Wherever it is appropriate, given pupils' security of understanding and readiness to progress, pupils should be taught the full content set out in this programme of study.

Working mathematically

Through the mathematics content, pupils should be taught to:

Develop fluency

- consolidate their numerical and mathematical capability from key stage 3 and extend their understanding of the number system to include powers, roots {**and fractional indices**}
- select and use appropriate calculation strategies to solve increasingly complex problems, including exact calculations involving multiples of π {**and surds**}, use of standard form and application and interpretation of limits of accuracy

- consolidate their algebraic capability from key stage 3 and extend their understanding of algebraic simplification and manipulation to include quadratic expressions, {**and expressions involving surds and algebraic fractions**}
- extend fluency with expressions and equations from key stage 3, to include quadratic equations, simultaneous equations and inequalities

- move freely between different numerical, algebraic, graphical and diagrammatic representations, including of linear, quadratic, reciprocal, {**exponential and trigonometric**} functions
- use mathematical language and properties precisely.

Reason mathematically

- extend and formalise their knowledge of ratio and proportion, including trigonometric ratios, in working with measures and geometry, and in working with proportional relations algebraically and graphically
- extend their ability to identify variables and express relations between variables algebraically and graphically
- make and test conjectures about the generalisations that underlie patterns and relationships; look for proofs or counter-examples; begin to use algebra to support and construct arguments {**and proofs**}
- reason deductively in geometry, number and algebra, including using geometrical constructions
- interpret when the structure of a numerical problem requires additive, multiplicative or proportional reasoning
- explore what can and cannot be inferred in statistical and probabilistic settings, and express their arguments formally
- assess the validity of an argument and the accuracy of a given way of presenting information.

Solve problems

- develop their mathematical knowledge, in part through solving problems and evaluating the outcomes, including multi-step problems
- develop their use of formal mathematical knowledge to interpret and solve problems, including in financial contexts
- make and use connections between different parts of mathematics to solve problems
- model situations mathematically and express the results using a range of formal mathematical representations, reflecting on how their solutions may have been affected by any modelling assumptions

- select appropriate concepts, methods and techniques to apply to unfamiliar and non routine problems; interpret their solution in the context of the given problem.

Subject content

Number

In addition to consolidating subject content from key stage 3, pupils should be taught to: ▪ apply systematic listing strategies, {**including use of the product rule for counting**} ▪ {**estimate powers and roots of any given positive number**}

▪ calculate with roots, and with integer {**and fractional**} indices

▪ calculate exactly with fractions, {**surds**} and multiples of π; {**simplify surd expressions involving squares [for example** = **rationalise denominators**} [redacted] **and**

▪ calculate with numbers in standard form $A \times 10^n$, where $1 \leq A < 10$ and n is an integer

▪ {**change recurring decimals into their corresponding fractions and vice versa**} ▪ identify and work with fractions in ratio problems

▪ apply and interpret limits of accuracy when rounding or truncating, {**including upper and lower bounds**}.

Algebra

In addition to consolidating subject content from key stage 3, pupils should be taught to:

▪ simplify and manipulate algebraic expressions (including those involving surds {**and algebraic fractions**}) by:

- factorising quadratic expressions of the form $x^2 + bx + c$, including the difference of two squares; {**factorising quadratic expressions of the form $ax^2 + bx + c$**}
- simplifying expressions involving sums, products and powers, including the laws of indices

▪ know the difference between an equation and an identity; argue mathematically to show algebraic expressions are equivalent, and use algebra to support and construct arguments {**and proofs**}

▪ where appropriate, interpret simple expressions as functions with inputs and outputs; {**interpret the reverse process as the 'inverse function'; interpret the succession of two functions as a 'composite function'**}

▪ use the form $y = mx + c$ to identify parallel {**and perpendicular**} lines; find the equation

of the line through two given points, or through one point with a given gradient

- identify and interpret roots, intercepts and turning points of quadratic functions graphically; deduce roots algebraically {**and turning points by completing the square**}
- recognise, sketch and interpret graphs of linear functions, quadratic functions, simple cubic functions, the reciprocal function $y = \frac{1}{x}$ with $x \neq 0$, {**the exponential function $y = k^x$ for positive values of k, and the trigonometric functions (with arguments in degrees) $y = \sin x$, $y = \cos x$ and $y = \tan x$ for angles of any size**}
- {**sketch translations and reflections of the graph of a given function**}
- plot and interpret graphs (including reciprocal graphs {**and exponential graphs**}) and graphs of non-standard functions in real contexts, to find approximate solutions to problems such as simple kinematic problems involving distance, speed and acceleration
- {**calculate or estimate gradients of graphs and areas under graphs (including quadratic and other non-linear graphs), and interpret results in cases such as distance-time graphs, velocity-time graphs and graphs in financial contexts**}
- {**recognise and use the equation of a circle with centre at the origin; find the equation of a tangent to a circle at a given point**}

solve quadratic equations {**including those that require rearrangement**} algebraically by factorising, {**by completing the square and by using the quadratic formula**}; find approximate solutions using a graph

solve two simultaneous equations in two variables (linear/linear {**or linear/quadratic**}) algebraically; find approximate solutions using a graph

- {**find approximate solutions to equations numerically using iteration**}
- translate simple situations or procedures into algebraic expressions or formulae; derive an equation (or two simultaneous equations), solve the equation(s) and interpret the solution
- solve linear inequalities in one {**or two**} variable{**s**}, {**and quadratic inequalities in one variable**}; represent the solution set on a number line, {**using set notation and on a graph**}
- recognise and use sequences of triangular, square and cube numbers, simple arithmetic progressions, Fibonacci type sequences, quadratic sequences, and simple geometric progressions (r^n where n is an integer, and r is a positive rational number {**or a surd**}) {**and other sequences**}
- deduce expressions to calculate the n^{th} term of linear {**and quadratic**} sequences.

Ratio, proportion and rates of change

In addition to consolidating subject content from key stage 3, pupils should be taught to:

- compare lengths, areas and volumes using ratio notation and/or scale factors; make links to similarity (including trigonometric ratios)
- convert between related compound units (speed, rates of pay, prices, density, pressure) in numerical and algebraic contexts
- understand that X is inversely proportional to Y is equivalent to X is proportional to $1 : Y$
  {**construct and**} interpret equations that describe direct and inverse proportion
- interpret the gradient of a straight line graph as a rate of change; recognise and interpret graphs that illustrate direct and inverse proportion
- {**interpret the gradient at a point on a curve as the instantaneous rate of change; apply the concepts of instantaneous and average rate of change (gradients of tangents and chords) in numerical, algebraic and graphical contexts**}
- set up, solve and interpret the answers in growth and decay problems, including compound interest {**and work with general iterative processes**}.

Geometry and measures

In addition to consolidating subject content from key stage 3, pupils should be taught to:

- interpret and use fractional {**and negative**} scale factors for enlargements
- {**describe the changes and invariance achieved by combinations of rotations, reflections and translations**}
- identify and apply circle definitions and properties, including: centre, radius, chord, diameter, circumference, tangent, arc, sector and segment
- {**apply and prove the standard circle theorems concerning angles, radii, tangents and chords, and use them to prove related results**}
- construct and interpret plans and elevations of 3D shapes
- interpret and use bearings
- calculate arc lengths, angles and areas of sectors of circles
- calculate surface areas and volumes of spheres, pyramids, cones and composite solids
- apply the concepts of congruence and similarity, including the relationships between lengths, {**areas and volumes**} in similar figures
- apply Pythagoras' Theorem and trigonometric ratios to find angles and lengths in right angled triangles {**and, where possible, general triangles**} in two {**and three**} dimensional figures

- know the exact values of $\sin\theta$ and $\cos\theta$ for $\theta = 0^0, 30^0, 45^0, 60^0$ and 90^0; know the exact value of $\tan\theta$ for $\theta = 0^0, 30^0, 45^0$ and 60^0

- {**know and apply the sine rule,** $\frac{a}{\sin B} = \frac{b}{\sin C}$**, and cosine rule,** $a^2 = b^2 + c^2 - 2bc\cos A$**, to find unknown lengths and angles**}

- {**know and apply triangle**} $\text{Area} = \frac{1}{2}ab\sin C$ **to calculate the area, sides or angles of any**

- describe translations as 2D vectors
- apply addition and subtraction of vectors, multiplication of vectors by a scalar, and diagrammatic and column representations of vectors; {**use vectors to construct geometric arguments and proofs**}.

Probability

In addition to consolidating subject content from key stage 3, pupils should be taught to:

- apply the property that the probabilities of an exhaustive set of mutually exclusive events sum to one
- use a probability model to predict the outcomes of future experiments; understand that empirical unbiased samples tend towards theoretical probability distributions, with increasing sample size

- calculate the probability of independent and dependent combined events, including using tree diagrams and other representations, and know the underlying assumptions
- {**calculate and interpret conditional probabilities through representation using expected frequencies with two-way tables, tree diagrams and Venn diagrams**}.

Statistics

In addition to consolidating subject content from key stage 3, pupils should be taught to:

- infer properties of populations or distributions from a sample, whilst knowing the limitations of sampling
- interpret and construct tables and line graphs for time series data
- {**construct and interpret diagrams for grouped discrete data and continuous data, i.e. histograms with equal and unequal class intervals and cumulative frequency graphs, and know their appropriate use**}
- interpret, analyse and compare the distributions of data sets from univariate empirical distributions through:
    - appropriate graphical representation involving discrete, continuous and grouped data, {**including box plots**}
    - appropriate measures of central tendency (including modal class) and spread {**including quartiles and inter-quartile range**}
- apply statistics to describe a population
- use and interpret scatter graphs of bivariate data; recognise correlation and know that it does not indicate causation; draw estimated lines of best fit; make predictions; interpolate and extrapolate apparent trends whilst knowing the dangers of so doing.

Science

Purpose of study

A high-quality science education provides the foundations for understanding the world through the specific disciplines of biology, chemistry and physics. Science has changed our lives and is vital to the world's future prosperity, and all pupils should be taught essential aspects of the knowledge, methods, processes and uses of science. Through building up a body of key foundational knowledge and concepts, pupils should be

encouraged to recognise the power of rational explanation and develop a sense of excitement and curiosity about natural phenomena. They should be encouraged to understand how science can be used to explain what is occurring, predict how things will behave, and analyse causes.

Aims

The national curriculum for science aims to ensure that all pupils:

- develop **scientific knowledge and conceptual understanding** through the specific disciplines of biology, chemistry and physics
- develop understanding of the **nature, processes and methods of science** through different types of science enquiries that help them to answer scientific questions about the world around them
- are equipped with the scientific knowledge required to understand the **uses and implications** of science, today and for the future.

Scientific knowledge and conceptual understanding

The programmes of study describe a sequence of knowledge and concepts. While it is important that pupils make progress, it is also vitally important that they develop secure understanding of each key block of knowledge and concepts in order to progress to the
next stage. Insecure, superficial understanding will not allow genuine progression: pupils may struggle at key points of transition (such as between primary and secondary school), build up serious misconceptions, and/or have significant difficulties in understanding higher-order content.

Pupils should be able to describe associated processes and key characteristics in common language, but they should also be familiar with, and use, technical terminology accurately and precisely. They should build up an extended specialist vocabulary. They should also apply their mathematical knowledge to their understanding of science, including collecting, presenting and analysing data. The social and economic implications of science are important but, generally, they are taught most appropriately within the wider

school curriculum: teachers will wish to use different contexts to maximise their pupils' engagement with and motivation to study science.

Spoken language

The national curriculum for science reflects the importance of spoken language in pupils' development across the whole curriculum – cognitively, socially and linguistically. The quality and variety of language that pupils hear and speak are key factors in developing their scientific vocabulary and articulating scientific concepts clearly and precisely. They must be assisted in making their thinking clear, both to themselves and others, and teachers should ensure that pupils build secure foundations by using discussion to probe and remedy their misconceptions.

Attainment targets

By the end of key stage 3 and 4, pupils are expected to know, apply and understand the matters, skills and processes specified in the relevant programme of study.

Introduction

The principal focus of science teaching in key stage 3 is to develop a deeper understanding of a range of scientific ideas in the subject disciplines of biology, chemistry and physics. Pupils should begin to see the connections between these subject areas and become aware of some of the big ideas underpinning scientific knowledge and understanding. Examples of these big ideas are the links between structure and function in living organisms, the particulate model as the key to understanding the properties and interactions of matter in all its forms, and the resources and means of transfer of energy

as key determinants of all of these interactions. They should be encouraged to relate scientific explanations to phenomena in the world around them and start to use modelling and abstract ideas to develop and evaluate explanations.

Pupils should understand that science is about working objectively, modifying explanations to take account of new evidence and ideas and subjecting results to peer review. Pupils should decide on the appropriate type of scientific enquiry to undertake to answer their own questions and develop a deeper understanding of factors to be taken into account when collecting, recording and processing data. They should evaluate their results and identify further questions arising from them.

'Working scientifically' is described separately at the beginning of the programme of study, but must always be taught through and clearly related to substantive science content in the programme of study. Teachers should feel free to choose examples that serve a variety of
purposes, from showing how scientific ideas have developed historically to reflecting modern developments in science.

Pupils should develop their use of scientific vocabulary, including the use of scientific nomenclature and units and mathematical representations.

Working scientifically

Through the content across all three disciplines, pupils should be taught to:

Scientific attitudes

- pay attention to objectivity and concern for accuracy, precision, repeatability and reproducibility
- understand that scientific methods and theories develop as earlier explanations are modified to take account of new evidence and ideas, together with the importance of publishing results and peer review
- evaluate risks.

Experimental skills and investigations

- ask questions and develop a line of enquiry based on observations of the real world, alongside prior knowledge and experience
- make predictions using scientific knowledge and understanding
- select, plan and carry out the most appropriate types of scientific enquiries to test predictions, including identifying independent, dependent and control variables, where appropriate
- use appropriate techniques, apparatus, and materials during fieldwork and laboratory work, paying attention to health and safety
- make and record observations and measurements using a range of methods for different investigations; and evaluate the reliability of methods and suggest possible improvements

- apply sampling techniques.

Analysis and evaluation

- apply mathematical concepts and calculate results
- present observations and data using appropriate methods, including tables and graphs
- interpret observations and data, including identifying patterns and using observations, measurements and data to draw conclusions
- present reasoned explanations, including explaining data in relation to predictions and hypotheses
- evaluate data, showing awareness of potential sources of random and systematic error
- identify further questions arising from their results.

Measurement

- understand and use SI units and IUPAC (International Union of Pure and Applied Chemistry) chemical nomenclature
- use and derive simple equations and carry out appropriate calculations
- undertake basic data analysis including simple statistical techniques.

Subject content – Biology

Pupils should be taught about:

Structure and function of living organisms

Cells and organisation

- cells as the fundamental unit of living organisms, including how to observe, interpret and record cell structure using a light microscope

- the functions of the cell wall, cell membrane, cytoplasm, nucleus, vacuole, mitochondria and chloroplasts
- the similarities and differences between plant and animal cells
- the role of diffusion in the movement of materials in and between cells
- the structural adaptations of some unicellular organisms
- the hierarchical organisation of multicellular organisms: from cells to tissues to organs to systems to organisms.

The skeletal and muscular systems

- the structure and functions of the human skeleton, to include support, protection, movement and making blood cells
- biomechanics – the interaction between skeleton and muscles, including the

measurement of force exerted by different muscles

- the function of muscles and examples of antagonistic muscles.

Nutrition and digestion

- content of a healthy human diet: carbohydrates, lipids (fats and oils), proteins, vitamins, minerals, dietary fibre and water, and why each is needed
- calculations of energy requirements in a healthy daily diet
- the consequences of imbalances in the diet, including obesity, starvation and deficiency diseases
- the tissues and organs of the human digestive system, including adaptations to function and how the digestive system digests food (enzymes simply as biological catalysts)
- the importance of bacteria in the human digestive system
- plants making carbohydrates in their leaves by photosynthesis and gaining mineral nutrients and water from the soil via their roots.

Gas exchange systems

- the structure and functions of the gas exchange system in humans, including adaptations to function
- the mechanism of breathing to move air in and out of the lungs, using a pressure model to explain the movement of gases, including simple measurements of lung volume
- the impact of exercise, asthma and smoking on the human gas exchange system
- the role of leaf stomata in gas exchange in plants.

Reproduction

- reproduction in humans (as an example of a mammal), including the structure and function of the male and female reproductive systems, menstrual cycle (without details

of hormones), gametes, fertilisation, gestation and birth, to include the effect of maternal lifestyle on the foetus through the placenta

- reproduction in plants, including flower structure, wind and insect pollination, fertilisation, seed and fruit formation and dispersal, including quantitative investigation of some dispersal mechanisms.

Health

- the effects of recreational drugs (including substance misuse) on behaviour, health and life processes.

Material cycles and energy

Photosynthesis

- the reactants in, and products of, photosynthesis, and a word summary for photosynthesis
- the dependence of almost all life on Earth on the ability of photosynthetic organisms, such as plants and algae, to use sunlight in photosynthesis to build organic molecules that are an essential energy store and to maintain levels of oxygen and carbon dioxide in the atmosphere
- the adaptations of leaves for photosynthesis.

Cellular respiration

- aerobic and anaerobic respiration in living organisms, including the breakdown of organic molecules to enable all the other chemical processes necessary for life
- a word summary for aerobic respiration
- the process of anaerobic respiration in humans and micro-organisms, including fermentation, and a word summary for anaerobic respiration
- the differences between aerobic and anaerobic respiration in terms of the reactants, the products formed and the implications for the organism.

Interactions and interdependencies

Relationships in an ecosystem

- the interdependence of organisms in an ecosystem, including food webs and insect pollinated crops
- the importance of plant reproduction through insect pollination in human food security
- how organisms affect, and are affected by, their environment, including the accumulation of toxic materials.

Genetics and evolution

Inheritance, chromosomes, DNA and genes

- heredity as the process by which genetic information is transmitted from one generation to the next
- a simple model of chromosomes, genes and DNA in heredity, including the part played by Watson, Crick, Wilkins and Franklin in the development of the DNA model
- differences between species
- the variation between individuals within a species being continuous or discontinuous, to include measurement and graphical representation of variation

- the variation between species and between individuals of the same species means some organisms compete more successfully, which can drive natural selection
- changes in the environment may leave individuals within a species, and some entire species, less well adapted to compete successfully and reproduce, which in turn may lead to extinction
- the importance of maintaining biodiversity and the use of gene banks to preserve hereditary material.

Subject content – Chemistry

Pupils should be taught about:

The particulate nature of matter

- the properties of the different states of matter (solid, liquid and gas) in terms of the particle model, including gas pressure
- changes of state in terms of the particle model.

Atoms, elements and compounds

- a simple (Dalton) atomic model
- differences between atoms, elements and compounds
- chemical symbols and formulae for elements and compounds
- conservation of mass changes of state and chemical reactions.

Pure and impure substances

- the concept of a pure substance
- mixtures, including dissolving
- diffusion in terms of the particle model

- simple techniques for separating mixtures: filtration, evaporation, distillation and chromatography
- the identification of pure substances.

Chemical reactions

- chemical reactions as the rearrangement of atoms
- representing chemical reactions using formulae and using equations ▪

combustion, thermal decomposition, oxidation and displacement reactions ▪

defining acids and alkalis in terms of neutralisation reactions ▪ the pH scale

for measuring acidity/alkalinity; and indicators

- reactions of acids with metals to produce a salt plus hydrogen
- reactions of acids with alkalis to produce a salt plus water
- what catalysts do.

Energetics

- energy changes on changes of state (qualitative)
- exothermic and endothermic chemical reactions (qualitative).

The Periodic Table

- the varying physical and chemical properties of different elements
- the principles underpinning the Mendeleev Periodic Table
- the Periodic Table: periods and groups; metals and non-metals ▪ how patterns in reactions can be predicted with reference to the Periodic Table ▪ the properties of metals and non-metals
- the chemical properties of metal and non-metal oxides with respect to acidity.

Materials

- the order of metals and carbon in the reactivity series
- the use of carbon in obtaining metals from metal oxides
- properties of ceramics, polymers and composites (qualitative).

Earth and atmosphere

- the composition of the Earth
- the structure of the Earth
- the rock cycle and the formation of igneous, sedimentary and metamorphic rocks
- Earth as a source of limited resources and the efficacy of recycling ▪ the carbon cycle

- the composition of the atmosphere
- the production of carbon dioxide by human activity and the impact on climate.

Subject content – Physics

Pupils should be taught about:

Energy

Calculation of fuel uses and costs in the domestic context

- comparing energy values of different foods (from labels) (kJ)
- comparing power ratings of appliances in watts (W, kW)
- comparing amounts of energy transferred (J, kJ, kW hour)
- domestic fuel bills, fuel use and costs
- fuels and energy resources.

Energy changes and transfers

- simple machines give bigger force but at the expense of smaller movement (and vice versa): product of force and displacement unchanged
- heating and thermal equilibrium: temperature difference between two objects leading to energy transfer from the hotter to the cooler one, through contact (conduction) or radiation; such transfers tending to reduce the temperature difference: use of insulators
- other processes that involve energy transfer: changing motion, dropping an object, completing an electrical circuit, stretching a spring, metabolism of food, burning fuels.

Changes in systems

- energy as a quantity that can be quantified and calculated; the total energy has the same value before and after a change
- comparing the starting with the final conditions of a system and describing increases and decreases in the amounts of energy associated with movements, temperatures, changes in positions in a field, in elastic distortions and in chemical compositions
- using physical processes and mechanisms, rather than energy, to explain the intermediate steps that bring about such changes.

Motion and forces

Describing motion

- speed and the quantitative relationship between average speed, distance and time (speed = distance ÷ time)

- the representation of a journey on a distance-time graph
- relative motion: trains and cars passing one another.

Forces

- forces as pushes or pulls, arising from the interaction between two objects
- using force arrows in diagrams, adding forces in one dimension, balanced and unbalanced forces
- moment as the turning effect of a force
- forces: associated with deforming objects; stretching and squashing – springs; with rubbing and friction between surfaces, with pushing things out of the way; resistance to motion of air and water

- forces measured in newtons, measurements of stretch or compression as force is changed
- force-extension linear relation; Hooke's Law as a special case
- work done and energy changes on deformation
- non-contact forces: gravity forces acting at a distance on Earth and in space, forces between magnets and forces due to static electricity.

Pressure in fluids

- atmospheric pressure, decreases with increase of height as weight of air above decreases with height
- pressure in liquids, increasing with depth; upthrust effects, floating and sinking
- pressure measured by ratio of force over area – acting normal to any surface.

Balanced forces

- opposing forces and equilibrium: weight held by stretched spring or supported on a compressed surface.

Forces and motion

- forces being needed to cause objects to stop or start moving, or to change their speed or direction of motion (qualitative only)
- change depending on direction of force and its size.

Waves

Observed waves

- waves on water as undulations which travel through water with transverse motion; these waves can be reflected, and add or cancel – superposition.

Sound waves

- frequencies of sound waves, measured in hertz (Hz); echoes, reflection and absorption of sound
- sound needs a medium to travel, the speed of sound in air, in water, in solids
- sound produced by vibrations of objects, in loud speakers, detected by their effects on microphone diaphragm and the ear drum; sound waves are longitudinal
- auditory range of humans and animals.

Energy and waves

- pressure waves transferring energy; use for cleaning and physiotherapy by ultra-sound; waves transferring information for conversion to electrical signals by microphone.

Light waves

- the similarities and differences between light waves and waves in matter
- light waves travelling through a vacuum; speed of light
- the transmission of light through materials: absorption, diffuse scattering and specular reflection at a surface
- use of ray model to explain imaging in mirrors, the pinhole camera, the refraction of light and action of convex lens in focusing (qualitative); the human eye
- light transferring energy from source to absorber leading to chemical and electrical effects; photo-sensitive material in the retina and in cameras
- colours and the different frequencies of light, white light and prisms (qualitative only); differential colour effects in absorption and diffuse reflection.

Electricity and electromagnetism

Current electricity

- electric current, measured in amperes, in circuits, series and parallel circuits, currents add where branches meet and current as flow of charge
- potential difference, measured in volts, battery and bulb ratings; resistance, measured in ohms, as the ratio of potential difference (p.d.) to current
- differences in resistance between conducting and insulating components (quantitative).

Static electricity

- separation of positive or negative charges when objects are rubbed together: transfer of electrons, forces between charged objects
- the idea of electric field, forces acting across the space between objects not in contact.

Magnetism

- magnetic poles, attraction and repulsion
- magnetic fields by plotting with compass, representation by field lines
- Earth's magnetism, compass and navigation
- the magnetic effect of a current, electromagnets, D.C. motors (principles only).

Matter

Physical changes

- conservation of material and of mass, and reversibility, in melting, freezing,

evaporation, sublimation, condensation, dissolving

- similarities and differences, including density differences, between solids, liquids and gases
- Brownian motion in gases
- diffusion in liquids and gases driven by differences in concentration
- the difference between chemical and physical changes.

Particle model

- the differences in arrangements, in motion and in closeness of particles explaining changes of state, shape and density, the anomaly of ice-water transition
- atoms and molecules as particles.

Energy in matter

- changes with temperature in motion and spacing of particles
- internal energy stored in materials.

Space physics

- gravity force, weight = mass x gravitational field strength (g), on Earth g=10 N/kg, different on other planets and stars; gravity forces between Earth and Moon, and between Earth and Sun (qualitative only)
- our Sun as a star, other stars in our galaxy, other galaxies
- the seasons and the Earth's tilt, day length at different times of year, in different hemispheres
- the light year as a unit of astronomical distance.

Introduction

Teaching in the sciences in key stage 4 continues with the process of building upon and deepening scientific knowledge and the understanding of ideas developed in earlier key stages in the subject disciplines of biology, chemistry and physics.

For some students, studying the sciences in key stage 4 provides the platform for more advanced studies, establishing the basis for a wide range of careers. For others, it will be their last formal study of subjects that provide the foundations for understanding the

natural world and will enhance their lives in an increasingly technological society.

Science is changing our lives and is vital to the world's future prosperity, and all students should be taught essential aspects of the knowledge, methods, processes and uses of science. They should be helped to appreciate the achievements of science in showing how the complex and diverse phenomena of the natural world can be described in terms of a number of key ideas relating to the sciences which are inter-linked, and which are of universal application. These key ideas include:

- the use of conceptual models and theories to make sense of the observed diversity of natural phenomena
- the assumption that every effect has one or more cause
- that change is driven by interactions between different objects and systems
- that many such interactions occur over a distance and over time
- that science progresses through a cycle of hypothesis, practical experimentation, observation, theory development and review
- that quantitative analysis is a central element both of many theories and of scientific methods of inquiry.

The sciences should be taught in ways that ensure students have the knowledge to enable them to develop curiosity about the natural world, insight into working scientifically, and appreciation of the relevance of science to their everyday lives, so that students:

- develop scientific knowledge and conceptual understanding through the specific disciplines of biology, chemistry and physics;
- develop understanding of the nature, processes and methods of science, through different types of scientific enquiry that help them to answer scientific questions about the world around them;

- develop and learn to apply observational, practical, modelling, enquiry, problem-solving skills and mathematical skills, both in the laboratory, in the field and in other environments;
- develop their ability to evaluate claims based on science through critical analysis of the methodology, evidence and conclusions, both qualitatively and quantitatively.

Curricula at key stage 4 should comprise approximately equal proportions of biology, chemistry and physics. The relevant mathematical skills required are covered in the programme of study for mathematics and should be embedded in the science context.

'Working scientifically' is described separately at the beginning of the programme of study, but must always be taught through and clearly related to substantive science content in the programme of study. Teachers should feel free to choose examples that

serve a variety of
purposes, from showing how scientific ideas have developed historically to reflecting modern developments in science and informing students of the role of science in understanding the causes of and solutions to some of the challenges facing society.

The scope and nature of their study should be broad, coherent, practical and rigorous, so that students are inspired and challenged by the subject and its achievements.

Working scientifically

Through the content across all three disciplines, students should be taught so that they develop understanding and first-hand experience of:

The development of scientific thinking

- the ways in which scientific methods and theories develop over time
- using a variety of concepts and models to develop scientific explanations and understanding
- appreciating the power and limitations of science and considering ethical issues

which may arise

- explaining everyday and technological applications of science; evaluating associated personal, social, economic and environmental implications; and making decisions based on the evaluation of evidence and arguments
- evaluating risks both in practical science and the wider societal context, including perception of risk
- recognising the importance of peer review of results and of communication of results to a range of audiences.

Experimental skills and strategies

- using scientific theories and explanations to develop hypotheses
- planning experiments to make observations, test hypotheses or explore phenomena
- applying a knowledge of a range of techniques, apparatus, and materials to select those appropriate both for fieldwork and for experiments
- carrying out experiments appropriately, having due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations
- recognising when to apply a knowledge of sampling techniques to ensure any samples collected are representative
- making and recording observations and measurements using a range of apparatus and methods
- evaluating methods and suggesting possible improvements and further investigations.

Analysis and evaluation

- applying the cycle of collecting, presenting and analysing data, including:
- presenting observations and other data using appropriate methods ▪

translating data from one form to another

- carrying out and representing mathematical and statistical analysis

- representing distributions of results and making estimations of uncertainty
- interpreting observations and other data, including identifying patterns and trends, making inferences and drawing conclusions
- presenting reasoned explanations, including relating data to hypotheses
- being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error
- communicating the scientific rationale for investigations, including the methods used, the findings and reasoned conclusions, using paper-based and electronic reports and presentations.

Vocabulary, units, symbols and nomenclature

- developing their use of scientific vocabulary and nomenclature
- recognising the importance of scientific quantities and understanding how they are determined
- using SI units and IUPAC chemical nomenclature unless inappropriate
- using prefixes and powers of ten for orders of magnitude (e.g. tera, giga, mega, kilo, centi, milli, micro and nano)
- interconverting units
- using an appropriate number of significant figures in calculations.

Subject content – Biology

Biology is the science of living organisms (including animals, plants, fungi and microorganisms) and their interactions with each other and the environment. The study of biology involves collecting and interpreting information about the natural world to identify patterns and relate possible cause and effect. Biology is used to help humans improve their own lives and to understand the world around them.

Students should be helped to understand how, through the ideas of biology, the complex and diverse phenomena of the natural world can be described in terms of a number of key ideas which are of universal application, and which can be illustrated in the separate topics set out below. These ideas include:

- life processes depend on molecules whose structure is related to their function
- the fundamental units of living organisms are cells, which may be part of highly adapted structures including tissues, organs and organ systems, enabling life processes to be performed more effectively

- living organisms may form populations of single species, communities of many species and ecosystems, interacting with each other, with the environment and with humans in many different ways
- living organisms are interdependent and show adaptations to their environment
- life on Earth is dependent on photosynthesis in which green plants and algae trap light from the Sun to fix carbon dioxide and combine it with hydrogen from water to make organic compounds and oxygen
- organic compounds are used as fuels in cellular respiration to allow the other chemical reactions necessary for life
- the chemicals in ecosystems are continually cycling through the natural world

- the characteristics of a living organism are influenced by its genome and its interaction with the environment
- evolution occurs by the process of natural selection and accounts both for biodiversity and how organisms are all related to varying degrees.

Students should be taught about:

Cell biology

- cells as the basic structural unit of all organisms; adaptations of cells related to their functions; the main sub-cellular structures of eukaryotic and prokaryotic cells
- stem cells in animals and meristems in plants
- enzymes
- factors affecting the rate of enzymatic reactions
- the importance of cellular respiration; the processes of aerobic and anaerobic respiration
- carbohydrates, proteins, nucleic acids and lipids as key biological molecules.

Transport systems

- the need for transport systems in multicellular organisms, including plants - the relationship between the structure and functions of the human circulatory system.

Health, disease and the development of medicines

- the relationship between health and disease
- communicable diseases including sexually transmitted infections in humans (including HIV/AIDs)
- non-communicable diseases

- bacteria, viruses and fungi as pathogens in animals and plants
- body defences against pathogens and the role of the immune system against disease
- reducing and preventing the spread of infectious diseases in animals and plants - the process of discovery and development of new medicines
- the impact of lifestyle factors on the incidence of non-communicable diseases.

Coordination and control

- principles of nervous coordination and control in humans

- the relationship between the structure and function of the human nervous system
- the relationship between structure and function in a reflex arc
- principles of hormonal coordination and control in humans
- hormones in human reproduction, hormonal and non-hormonal methods of contraception
- homeostasis.

Photosynthesis

- photosynthesis as the key process for food production and therefore biomass for life
- the process of photosynthesis
- factors affecting the rate of photosynthesis.

Ecosystems

- levels of organisation within an ecosystem
- some abiotic and biotic factors which affect communities; the importance of interactions between organisms in a community
- how materials cycle through abiotic and biotic components of ecosystems
- the role of microorganisms (decomposers) in the cycling of materials through an ecosystem
- organisms are interdependent and are adapted to their environment
- the importance of biodiversity
- methods of identifying species and measuring distribution, frequency and abundance of species within a habitat
- positive and negative human interactions with ecosystems.

Evolution, inheritance and variation

- the genome as the entire genetic material of an organism
- how the genome, and its interaction with the environment, influence the development of the phenotype of an organism
- the potential impact of genomics on medicine
- most phenotypic features being the result of multiple, rather than single, genes
- single gene inheritance and single gene crosses with dominant and recessive

phenotypes

- sex determination in humans
- genetic variation in populations of a species
- the process of natural selection leading to evolution
- the evidence for evolution
- developments in biology affecting classification
- the importance of selective breeding of plants and animals in agriculture
- the uses of modern biotechnology including gene technology; some of the practical and ethical considerations of modern biotechnology.

Subject content – Chemistry

Chemistry is the science of the composition, structure, properties and reactions of matter, understood in terms of atoms, atomic particles and the way they are arranged and link together. It is concerned with the synthesis, formulation, analysis and characteristic properties of substances and materials of all kinds.

Students should be helped to appreciate the achievements of chemistry in showing how the complex and diverse phenomena of both the natural and man-made worlds can be described in terms of a number of key ideas which are of universal application, and which can be illustrated in the separate topics set out below. These ideas include:

- matter is composed of tiny particles called atoms and there are about 100 different naturally-occurring types of atoms called elements
- elements show periodic relationships in their chemical and physical properties
- these periodic properties can be explained in terms of the atomic structure of the elements

- atoms bond either by transferring electrons from one atom to another or by sharing electrons
- the shapes of molecules (groups of atoms bonded together) and the way giant structures are arranged is of great importance in terms of the way they behave
- reactions can occur when molecules collide and do so at different rates due to differences in molecular collisions
- chemical reactions take place in only three different ways:
    - proton transfer

- electron transfer
- electron sharing

- energy is conserved in chemical reactions so can therefore be neither created nor destroyed.

Students should be taught about:

Atomic structure and the Periodic Table

- a simple model of the atom consisting of the nucleus and electrons, relative atomic mass, electronic charge and isotopes
- the number of particles in a given mass of a substance
- the modern Periodic Table, showing elements arranged in order of atomic number
- position of elements in the Periodic Table in relation to their atomic structure and arrangement of outer electrons
- properties and trends in properties of elements in the same group
- characteristic properties of metals and non-metals
- chemical reactivity of elements in relation to their position in the Periodic Table.

Structure, bonding and the properties of matter

- changes of state of matter in terms of particle kinetics, energy transfers and the relative strength of chemical bonds and intermolecular forces
- types of chemical bonding: ionic, covalent, and metallic
- bulk properties of materials related to bonding and intermolecular forces
- bonding of carbon leading to the vast array of natural and synthetic organic compounds that occur due to the ability of carbon to form families of similar compounds, chains and rings
- structures, bonding and properties of diamond, graphite, fullerenes and graphene.

Chemical changes

- determination of empirical formulae from the ratio of atoms of different kinds
- balanced chemical equations, ionic equations and state symbols ▪

identification of common gases

- the chemistry of acids; reactions with some metals and carbonates ▪ pH

as a measure of hydrogen ion concentration and its numerical scale ▪

electrolysis of molten ionic liquids and aqueous ionic solutions

- reduction and oxidation in terms of loss or gain of oxygen.

Energy changes in chemistry

- Measurement of energy changes in chemical reactions (qualitative) - Bond breaking, bond making, activation energy and reaction profiles (qualitative).

Rate and extent of chemical change

- factors that influence the rate of reaction: varying temperature or concentration, changing the surface area of a solid reactant or by adding a catalyst
- factors affecting reversible reactions.

Chemical analysis

- distinguishing between pure and impure substances
- separation techniques for mixtures of substances: filtration, crystallisation, chromatography, simple and fractional distillation
- quantitative interpretation of balanced equations
- concentrations of solutions in relation to mass of solute and volume of solvent.

Chemical and allied industries

- life cycle assessment and recycling to assess environmental impacts associated with all the stages of a product's life
- the viability of recycling of certain materials
- carbon compounds, both as fuels and feedstock, and the competing demands for limited resources
- fractional distillation of crude oil and cracking to make more useful materials
- extraction and purification of metals related to the position of carbon in a reactivity series.

Earth and atmospheric science

- evidence for composition and evolution of the Earth's atmosphere since its formation
- evidence, and uncertainties in evidence, for additional anthropogenic causes of climate change
- potential effects of, and mitigation of, increased levels of carbon dioxide and methane on the Earth's climate

- common atmospheric pollutants: sulphur dioxide, oxides of nitrogen, particulates and their sources
- the Earth's water resources and obtaining potable water.

Subject content – Physics

Physics is the science of the fundamental concepts of field, force, radiation and particle structures, which are inter-linked to form unified models of the behaviour of the material universe. From such models, a wide range of ideas, from the broadest issue of the development of the universe over time to the numerous and detailed ways in which new technologies may be invented, have emerged. These have enriched both our basic understanding of, and our many adaptations to, our material environment.

Students should be helped to understand how, through the ideas of physics, the complex and diverse phenomena of the natural world can be described in terms of a number of key ideas which are of universal application and which can be illustrated in the separate topics set out below. These ideas include:

- the use of models, as in the particle model of matter or the wave models of light and of sound
- the concept of cause and effect in explaining such links as those between force and acceleration, or between changes in atomic nuclei and radioactive emissions
- the phenomena of 'action at a distance' and the related concept of the field as the key to analysing electrical, magnetic and gravitational effects
- that differences, for example between pressures or temperatures or electrical potentials, are the drivers of change
- that proportionality, for example between weight and mass of an object or between force and extension in a spring, is an important aspect of many models in science.

Students should be taught about:

Energy

- energy changes in a system involving heating, doing work using forces, or doing work using an electric current; calculating the stored energies and energy changes involved

- power as the rate of transfer of energy
- conservation of energy in a closed system; dissipation
- calculating energy efficiency for any energy transfers
- renewable and non-renewable energy sources used on Earth; changes in how these are used.

Forces

- forces and fields: electrostatic, magnetic, gravity
- forces as vectors
- calculating work done as force x distance; elastic and inelastic stretching
- pressure in fluids acts in all directions: variation in Earth's atmosphere with height, with depth for liquids, up-thrust force (qualitative).

Forces and motion

- speed of sound; estimating speeds and accelerations in everyday contexts
- interpreting quantitatively graphs of distance, time, and speed
- acceleration caused by forces; Newton's First Law
- weight and gravitational field strength
- decelerations and braking distances involved on roads.

Wave motion

- amplitude, wavelength and frequency; relating velocity to frequency and wavelength
- transverse and longitudinal waves
- electromagnetic waves and their velocity in vacuum; waves transferring energy; wavelengths and frequencies from radio to gamma-rays
- velocities differing between media: absorption, reflection, refraction effects ▪

production and detection, by electrical circuits, or by changes in atoms and nuclei

- uses in the radio, microwave, infra-red, visible, ultra-violet, X-ray and gamma-ray regions, hazardous effects on bodily tissues.

Electricity

- measuring resistance using p.d. and current measurements
- exploring current, resistance and voltage relationships for different circuit elements, including their graphical representations

- quantity of charge flowing as the product of current and time
- drawing circuit diagrams; exploring equivalent resistance for resistors in series
- the domestic a.c. supply; live, neutral and earth mains wires; safety measures ▪

power transfer related to p.d. and current, or current and resistance.

Magnetism and electromagnetism

- exploring the magnetic fields of permanent and induced magnets, and the Earth's magnetic field, using a compass
- magnetic effects of currents; how solenoids enhance the effect
- how transformers are used in the national grid and the reasons for their use.

The structure of matter

- relating models of arrangements and motions of the molecules in solid, liquid and gas phases to their densities
- melting, evaporation, and sublimation as reversible changes
- calculating energy changes involved on heating, using specific heat capacity; and those involved in changes of state, using specific latent heat
- links between pressure and temperature of a gas at constant volume, related to the motion of its particles (qualitative).

Atomic structure

- the nuclear model and its development in the light of changing evidence
- masses and sizes of nuclei, atoms and small molecules
- differences in numbers of protons and neutrons related to masses and identities of nuclei; isotope characteristics and equations to represent changes
- ionisation; absorption or emission of radiation related to changes in electron orbits
- radioactive nuclei; emission of alpha or beta particles, neutrons, or gamma-rays, related to changes in the nuclear mass and/or charge
- radioactive materials, half-life, irradiation, contamination and their associated hazardous effects; waste disposal
- nuclear fission, nuclear fusion and our Sun's energy

Space physics

- the main features of the solar system.

Art and design

Purpose of study

Art, craft and design embody some of the highest forms of human creativity. A high-quality art and design education should engage, inspire and challenge pupils, equipping them with the knowledge and skills to experiment, invent and create their own works of art, craft and design. As pupils progress, they should be able to think critically and develop a more rigorous understanding of art and design. They should also know how art and design both reflect and shape our history, and contribute to the culture, creativity and wealth of our nation.

Aims

The national curriculum for art and design aims to ensure that all pupils: ▪

produce creative work, exploring their ideas and recording their experiences

- become proficient in drawing, painting, sculpture and other art, craft and design techniques
- evaluate and analyse creative works using the language of art, craft and design
- know about great artists, craft makers and designers, and understand the historical and cultural development of their art forms.

Attainment targets

By the end of key stage 3, pupils are expected to know, apply and understand the matters, skills and processes specified in the programme of study.