

Science in KS4: an overview and rationale

Our aims: AO1, AO2, AO3

The first main aim of the KS4 curriculum is to build on content first covered in KS3, consolidating key ideas and then progressing understanding to a deeper level, in order to prepare students for KS4 linear exams and beyond. The spiralling nature of our curriculum allows for student progress from KS3 understanding to more challenging KS4 levels. All medium term KS4 plans specify specifically where content links back to prior knowledge in KS3. Knowledge based content is broken down into AO1 (recall of content) and AO2 (application of content). Often it is the application of knowledge that allows us to really stretch student understanding, encouraging students to answer questions and explain novel contexts using their understanding of science. This makes for an ambitious curriculum which stretches students across all of the subjects and courses that make up our entire curriculum.

The second main aim for our KS4 curriculum is to continue to embed key science, literacy and numeracy skills by using content as a vehicle to allow students to practice these skills. Most of the skills will have been encountered during KS3 allowing us to increase the challenge level by KS4. We believe that the skill set our students develop will help them to perform confidently not just in science but in other areas too. Most of the science skills we cover in science are referred to as 'AO3'. Students should be aware of these terms (AOs are stuck to the front of first books).

We expect that secure students will have an awareness of the following areas in each subject by the end of KS4:

Biology: cells/enzymes/transport applied to; ecology, hormones, transport systems, growth and cell division, genetics, evolution and genetic manipulation, disease and plants.

Chemistry: states of matter; atomic structure; bonding; reactions of acids, alkalis and electrolytes; reactions of group 1 and 7 metals; rates of reaction; reactions of hydrocarbons.

Physics: speed and forces; energy; waves and EM spectrum; radioactivity; electricity; magnetism; particle theory; energy changes

For full details, see the Edexcel Combined/Separate Sciences specifications.

Organisation and delivery:

Science in KS4 follows 2 distinct pathways through all 3 science subjects. Students either study combined science or separate (triple) sciences depending on their option choices in Y9. Both pathways follow the Edexcel GCSE programme of study.

Students are arranged into sets which are continually reviewed based on student performance. Sets 2 and 4 typically cover higher tier combined science. Sets 6-8 cover mostly foundation tier combined science. Sets 1 and (usually) 3 cover triple science to higher level although some will sit foundation tier for the final exam. We pride ourselves on making triple science available to foundation tier students as we believe any student who is passionate about science should be able to study triple at GCSE. The average % of students taking triple science is generally much higher than in other schools- typically up to 30% of the cohort.

In addition, we are piloting our lowest sets also being entered for the Entry Level Science qualification. This does not replace GCSE but rather runs alongside it. We believe that offering this qualification may offer an opportunity to build confidence in our lowest ability students, with the externally moderated modular exams serving to motivate students by offering an extra qualification.

Students have 3 separate subject specialist teachers for each of biology, chemistry and physics to help them distinguish between the 3 subjects. Staff have relevant training in their subject where appropriate but since this is not always possible due to national shortages for some specialisms, we have created a collaborative bank of resources and module plans for each subject. Staff are free to use their own resources if they wish but are aware

that a bank of high quality resources exists should they need them. Regular working parties within specialisms and inter-subject moderation allow us to review and improve the resource bank where needed.

As with KS3, KS4 teaching and learning follows guidance set out in the EEF Improving Secondary Science report (2017). This can be viewed in Appendix B.

Skills

We ensure that every module is used as a vehicle to teach valuable key skills that students need to be successful in science and beyond. These are taught within the required content, providing a range of contexts to which skills can be applied. Some of these skills are scientific skills (all those listed in the Edexcel guidance are covered by our curriculum model and more!)- e.g. devising experimental procedure, identifying experimental variables, working safely etc.

We also focus on numeracy skills- we have worked extensively with the maths department to develop coherent procedures for teaching key maths skills and continue to do so in order to continually improve current practice. The numeracy skills covered match science requirements outlined by the DfE and continue to build on the skills embedded in the KS3 curriculum. Maths makes up a large proportion of our science curriculum hence we place great emphasis on ensuring we teach it well and embed those key skills carefully.

Literacy skills are also an obvious focus within the science curriculum. We continue to build on literacy skills embedded within the KS3 curriculum and provide opportunities for extended writing practice where possible. Students can sometimes lose confidence when asked to write longer answers so we work carefully on building confidence throughout the course.

Medium term plans for each subject highlight where specific skills are taught explicitly within units but most skills underpin content throughout the entirety of the curriculum.

Teaching order

We generally agree with the teaching order outlined by the Edexcel specification (although a slightly altered version is being piloted for chemistry at present to try and support student understanding of key ideas). This allows us to start with key concepts in each subject which students can then apply to novel contexts encountered throughout the curriculum. For example, enzymes are taught at the start of the biology course so that students can apply this understanding to e.g. photosynthesis rates and thermoregulation. We do also make some slight tweaks to content for more practical reasons. Topic 9 is taught earlier in Y11 because this coincides with more clement weather enabling us to carry out field work. In physics, the particle and stretching module is taught earlier than suggested in the Edexcel scheme of work because we feel it is beneficial to make links to energy and power which are taught earlier in the course.

The spiralling nature of the curriculum allows for a seamless progression from KS3 in Y9 onto key KS4 principles.

So overall, we follow the guidance set out by the exam boards but make necessary changes to the order where we feel it will benefit student understanding.

Engagement and motivation

KS4 students are given opportunities to carry out practical work wherever it is possible. We feel it is important that this is carried out with clear purpose so that it compliments learning and/or skill development. Practical work engages students and makes them excited about science so we try to include it where possible. Using real world contexts and familiar and/or interesting situations are also another key part of the science curriculum. Students are more engaged and interested when they can apply abstract knowledge to something they know or are interested in. Examples of this can be found throughout the KS4 resources for all 3 subjects.

Students should also be sufficiently challenged to motivate and engage them, using appropriate scaffolding where needed to access harder tasks or difficult content.

Regular assessment allows teachers to check that students are engaging with work as requested. Teachers should also subscribe to the 'live marking' policy seen across school.

We incorporate the school reward card system into lessons and tasks- often there are opportunities for competition which motivates students greatly (especially boys). This is used in addition to the science department reward cards and prize bag.

Where possible, links are made to A level, University, careers and industry to provide inspiration for students who may be considering post-KS4 pathways. This raises aspirations of students and makes them more inclined to be motivated to succeed. These links are referred to in medium term plans.

Adaptive practice- challenge and support

As discussed earlier, KS4 Science is naturally differentiated by having H and F tier levels and combined and triple content. Therefore our setting and continual review of student progress within sets acts as a tool for support and challenge. However, resources are also differentiated within sets where necessary to provide at least H and F options.

Assessed tasks and tests are also tiered to provide appropriate support and challenge. We try to challenge the majority of sets 1-5 by providing access to higher material and resources where appropriate.

Our lowest sets complete the Entry Level Science Award alongside their GCSE course. We feel this has a positive impact on student retrieval and confidence.

Intervention is often used to support students where needed across all sets. This runs all year round, including informal drop ins which all students can access. Intervention includes small-group tutoring to cover the more challenging topics.

Where students require it, sets are supported by SSAs who will co-plan with teaching staff in order to best support students who need it. Staff should be aware of specific needs by individuals and ensure those needs are met in class.

The exploring science package that we subscribe to also has a bank of differentiated worksheets and assessments to stretch and challenge all abilities.

Specific modules have additional challenge material included- including reading opportunities where appropriate. Staff received CPD in how best to challenge students and a range of suggested activity ideas (Jan 2020).

Independence

Each module in KS4 has an end of unit test attached to it and we set revision as an at home task regularly. This serves to promote independence, help students to consolidate understanding and prepares students for the rigour of linear exams.

Within class, students are encouraged to be resilient and independent learners with a range of types of activity. Structure questioning also promotes independent thinking and resilience in class. Tasks have been designed to stretch and challenge and promote independent discussion with peers.

Regular retrieval testing is something we have built into our KS4 curriculum in order to encourage students to review prior learning. By setting regular retrieval testing and often linking this to competition we can encourage students to revise and reflect independently.

Every KS4 module has a supporting 'consolidation booklet'. These comprehension-based tasks with practice questions are multi-purpose, being useful for revision, catch-up or simply consolidation of learning. Their comprehensive nature allows students to work independently to improve their understanding. Each booklet is accompanied by a pre-recorded teacher 'walk through' to assist with independent learning.

Towards the end of KS4 staff share a revision plan with students, detailing what will be recovered in class and by when, as well as dates of mock exams. This provides a timeline for students to then create their own revision timetable and to seek support through relevant intervention. This document helps students to take control of their own revision process.

Literacy and communication

Tier 2 command words are used throughout the KS4 curriculum in order to build student confidence in recognising exam terminology. This also generally improves student vocabulary. Students are introduced to these command words from Y7 onwards so that they are used to using them with confidence by KS4.

Every module has a tier 3 vocabulary list which should be available to students. This includes definitions, spellings and pronunciation to encourage students to be more confident in reading aloud.

To help students meet the literacy requirements of KS4 we have embedded key literacy skills into the KS3 curriculum. This continues into KS4 with opportunities for reading, extended writing and use of tier 3 terminology throughout. More specific literacy skills are also addressed in some parts of the curriculum- writing comparatively for example.

Oracy continues to be used to help improve student communication. This is evident throughout the departmental resources with use of sentence stems to support discussion.

Numeracy

Our KS4 curriculum has a large maths requirement so we firmly embed key maths skills into our KS3 curriculum. The practice of these skills continues with increasing levels of challenge into KS4. We have communicated with the maths department to ensure that we teach skills in an order that compliments their curriculum. Accessing maths in a cross curricular manner will help to improve students' general maths skills. It is an important part of our curriculum.

The DfE science maths requirements are addressed across the entirety of our curriculum. We also offer specific intervention activities which look specifically at applying maths to science concepts. These build student confidence so that they are more inclined to apply what they learn in maths to their science lessons. We reinforce this cross curricular link often.

Assessment

Each module has a teacher assessed task and an end of unit test attached to it. The teacher assessed task has been specially developed with student substantive and disciplinary needs in mind (using resultsplus data to identify historically challenging areas) and can be completed using notes to consolidate understanding in class and build student confidence. These assessments focus on disciplinary knowledge and retrieval in addition to substantive content. The test should be given as summative assessment at the end of each module to ensure students have a good understanding of the required specification points and to practise relevant disciplinary knowledge. Revision at home should be set as regular homework to encourage independent revision.

Both types of assessed task should be marked in accordance with the science department marking policy in a timely manner.

Throughout the year students are also given bigger mock exams which they are also given time to revise for. These increase in frequency towards the end of the KS4 course. They offer important exam practice and confidence building in revision of larger chunks of information as well as allowing staff to decide with tier entry and set students should be entered for.

Community and cultural capital

This is highlighted for individual modules in the medium term plan for each module we teach. Generally speaking, we provide a plethora of opportunities for students to make connections with the world they live in- it is hard not to in science since it is the study of life itself! Teachers are passionate about their subject and this shows in their teaching style. Teachers use real world examples as vehicles for teaching abstract content. In many lessons we try to incorporate aspects of the local community- using local geography, ecology and industry as examples. For example, we refer to local ecosystems when teaching the ecology topic. The KS4 curriculum also provides opportunities for students to critically analyse information about key issues like climate change and to use data and scientific models to come to conclusions (rather than what they see on social media or statements from people with an agenda). This makes them more informed citizens. Our curriculum also builds in opportunities to debate ethical issues- for example looking at building nuclear power stations in physics. We use ethical issues in science as grounds to develop communication skills through oracy techniques.

To build aspirations and encourage students to think about career pathways, career spotlight activities are built into the KS4 curriculum (e.g. career focus cards linked to most units) and local industries may be referred to in relevant modules. Cultural capital is also developed by offering extra science drop in clubs and science trips (for example, KS4 went to Blyth in recent years to investigate renewable energy and some also took part in externally ran interactive medical activities via 'Medical Mavericks').

Cross-curricular links are made and highlighted regularly. This helps students to see the relevance in what they learn and to deepen their understanding in both science and other subjects.

As with KS3, we aim to develop students as individuals by equipping them with skills for the wider world outside of their science lessons. This is apparent in working to improve numeracy, literacy and communication skills for example and in encouraging students to investigate ideas and other opinions for themselves. We believe this makes for confident, resilient and independent learners.

Disadvantaged students

Staff should be aware of those students who fall into 'disadvantaged' groups. Progress of such students should be monitored using the assessment methods illustrated above.

We redesigned our KS3 curriculum to address some of the historical issues we had seen regarding literacy, numeracy and key science skills. We believe that (given time) we should see that the enrichment of our KS3 curriculum helps to support progress of relevant students in KS4. This skills focus work continues throughout KS4 and there is a heavy focus on literacy and reading in order to support student use and understanding of tier 2 and 3 vocabulary.

Intervention is critical in supporting all students, including those in the disadvantaged cohort. In the past we have used focused morning intervention slots to support identified students.

We are mindful of issues such as cost of revision guides and tutoring so we offer revision resources and small group tutoring at no cost to students.

Blended learning and covid recovery

Ensuring students have time to practice disciplinary knowledge alongside substantive content.

Specific intervention occurs throughout the year to target specific groups of students.

Revision time prior to GCSEs will be structured to ensure topics are revisited and understanding established. This is something that we do anyway- this will be built into revision plans as outlined above. Retrieval testing will also offer support in revisiting concepts.

The consolidation booklets and narrated videos cover each and every module and provide a foundation with which external parties can work with students. Summary posters have also been created for every module.

Appendix A

Skills taught within KS4 curriculum content with examples of where to find opportunities to teach them (not necessarily limited to that module- explicit examples listed)

Science skills	Numeracy skills	Literacy and communication skills
<ul style="list-style-type: none"> -Explaining graph trends (ALL) -Identifying variables (T2/8 biology, T14 chemistry, T3 physics) -Devising an investigation (T2 biology, T1/14 chemistry, T4 physics) -Improving a method (T5/8 biology, T1/10 chemistry, T6 physics) -Identifying and minimising risk (T1/8 biology, T1/8 chemistry) -Writing a conclusion (T8/5 biology, chemistry- all core practicals) -Drawing a table (T8/2 biology, chemistry core practicals) -Retrieval testing- ALL 	<ul style="list-style-type: none"> -Describing graph trends (ALL) -Drawing graphs (ALL) -Identifying graph values (ALL) -Calculating averages (e.g. bio assessed task T5, Physics T5) -Giving answers to a specific number of decimal places/significant figures (e.g. biology T7/5, Chemistry T9) -Using and rearranging formula (e.g. physics ALL, biology T1, Chemistry T14/15) -Calculating % (e.g. T5/8 biology, T14/16 chemistry) -Calculating % change (Biology T1/2) -Using standard form (T1 physics, T1/7 biology, T9 chemistry. Generally H tier) 	<p>Throughout- but explicit examples listed:</p> <ul style="list-style-type: none"> -Use of oracy to promote effective discussion (ALL) Opportunities for reading (ALL) -Using tier 3 terminology (ALL) -Using tier 2 command words (ALL) -Extended writing practice (ALL) -Structuring answers/paragraphs (ALL) -Strategies for note taking (ALL- specific focus in biology T8/9) -Writing comparatively (specific examples in T2 Biology, T3/4 chemistry, T10/11 Physics) -Independent research/tasks (ALL- e.g. T5 biology specifically)

See skills audit document for a more detailed overview.

Appendix B

[Hyperlink](#) to summary of EEF recommendations (Improving Secondary Science, 2017)

Or see:

https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_science_summary_of_recommendations_poster.pdf

Appendix C

[Hyperlink](#) to biology specification

[Hyperlink](#) to chemistry specification

[Hyperlink](#) to physics specification

[Hyperlink](#) to combined science specification

[Hyperlink](#) to Entry Level specification