Science policy

Last updated by subject leader	September 2021
Last reviewed by Principal and Headteacher	September 2021
Next review due	September 2022

Overview

EYFS

The Foundation Stage deliver science content through the 'Understanding of the World' strand of the EYFS curriculum. This involves guiding children to make sense of their physical world and their community through opportunities to explore, observe and find out about people, places, technology and the environment. Children are assessed according to the Development Matters attainment targets.

Prep. School

Two lessons (2 x 50 minutes) of science are taught per week. All year 5 (F2) and year 6 (F3) pupils also have one extra 50 minute Science lesson per week in the Senior school, leading to either a STAR (F2 pupils) or a SUPERSTAR (F3 pupils) CREST award from the British Science Association.

Senior School

1st, 2nd, 3rd Forms (Key Stage 3 Science): Three lessons (3 x 50 minutes) per week split into one single and one double period. All pupils also have an additional 50 minute Science CREST lesson per week in the summer term, leading to one of the CREST awards (Discovery, Bronze, Silver) from the British Science Association.

4th, 5th Forms (GCSE Biology, GCSE Chemistry, GCSE Physics): Three lessons (3 x 50 minutes) per week **per subject** split into one single and one double period. For the 5th Form there is also an additional 50 minute exam practice tutorial per fortnight. Therefore, taking all three separate sciences results in nine periods of science education per week and for the 5th Form only plus three additional exam practice tutorials per fortnight.

4th Form: From September 2021 all pupils will be offered the AQA Level 1 Foundation Project Qualification (7991).

5th Form: From September 2021 all pupils will be offered the AQA Level 2 Higher Project Qualification (7992).

6th Form (AS & A Level Biology): **Six** lessons (6 x 50 minutes) per week split into two single and two double periods. Also, **one** 50 minute exam practice tutorial per week. One out of the six lessons is devoted to the AQA Level 3 Extended Project Qualification (7993), which all A Level Biology students do.

6th Form (AS & A Level Chemistry): **Five** lessons (5 x 50 minutes) per week split into one single and two double periods.

6th Form (AS & A Level Physics): **Seven** lessons (7 x 50 minutes) per week split into one single and three double periods.

Science department

The science department is comprised of four full time and three part time teachers as well as a full-time science technician. All science teachers are specialists in their areas of teaching. In department meetings teachers specialising in different areas of science share their expertise to aid the delivery of a holistic science curriculum, especially at KS2 transition, KS3 and certain KS4 topics, such as environmental science.

The subject leader

It is the responsibility of the subject leader to monitor the standards of pupils' work. The subject leader is also responsible for supporting colleagues in their teaching, for being informed about current developments in the subject, and for providing a strategic lead and direction for science across the school. The subject leader monitors resources, topics, books, trips and workshops to support learning.

Inclusion

We aim to meet the needs of all our pupils by differentiation in our science planning and in providing a variety of approaches and tasks appropriate to ability levels. This involves providing opportunities for pupils with SEND to complete their own projects. Some pupils require closer supervision and more adult support to allow them to progress whilst more able pupils are extended through differentiated activities. By being given enhancing and enriching activities, more able pupils are able to progress to a higher level of knowledge and understanding appropriate to their abilities. Teachers ensure that a range of strategies are used which include and motivate all pupils, ensuring that optimum progress is made throughout each part of the lesson.

Parents and homework

Parental input is highly valued and parents, when relevant are invited and welcomed into school to share their own expertise with pupils. Pupils receive science homework based on their current topic.

Professional development

Regular professional development starts in department meetings through sharing expertise and outstanding practice and extends to professional development offered by exam boards, for example, how to deliver effectively the A Level practical endorsements.

Science teachers attend annual conferences, such as the New Scientist Live. Although the conferences are primarily designed for pupils, they also aid teachers' professional development by coming across high calibre scientists and exam board delegates, such as Lord Winston, Professor Al-Khalili and AQA's Stewart Chenery.

Science department annual conferences:

- New Scientist Live
- GCSE Science Live
- A Level Biology in Action

- A Level Chemistry in Action
- A Level Physics in Action

The science qualifications offered are:

1. AS Biology
2. A Level Biology
3. Practical endorsement for A Level Biology

4. AS Chemistry
5. A Level Chemistry
6. Practical endorsement for A Level Chemistry

7. AS Physics
8. A Level Physics
9. Practical endorsement for A Level Physics

10. GCSE Biology
11. GCSE Chemistry
12. GCSE Physics

13. EPQ (Level 3)
14. EPQ (Level 2)
15. EPQ (Level 1)

16. Key Stage 1 & Key Stage 2 national assessments.

Additionally, we offer the British Science Association CREST awards:

1. Star (Prep, F2)
2. Superstar (Prep, F3)
3. Discovery (Senior, 1st Form)
4. Bronze (Senior, 2nd Form)
5. Silver (Senior, 3rd Form)
6. Gold (Senior, GCSE & A Level)

The Science department policy is complemented by the following schemes of work:

1. AQA AS & A Level Biology (7401, 7402) + Practical endorsement
2. AQA AS & A Level Chemistry (7404, 7405) + Practical endorsement
3. AQA AS & A Level Physics (7407, 7408) + Practical endorsement
4. AQA GCSE Biology
5. AQA GCSE Chemistry
6. AQA GCSE Physics
7. Kerboodle SoW for 'Activate Year 7'
8. Kerboodle SoW for 'Activate Year 8'
9. Kerboodle SoW for 'Activate Year 9'
10. KS1 & KS2 own schemes of work

Also:

1. AQA Guidelines for Level 1, 2, 3 EPQ (7991, 7992, 7993)
2. British Science Association CREST awards challenges

The schemes of work ensure the National curriculum aims are fully met.

Intent:*'To create the outstanding scientists of the future'.*

Key Stages 1 and 2

Class teachers are responsible for their own class organisation and teaching style in relation to science, while at the same time ensuring that these complement and reflect the overall aims and philosophy of both the School and the science department.

Within any one class and within the range of science topics/work pupils are given the opportunity to work as a class, as individuals and as part of a group. There are occasions when whole-class activities are appropriate in the teaching of science. These may include the introduction of a new topic or theme or the introduction of activities leading to further group work.

Group work offers pupils opportunities to work together, sharing ideas and offering suggestions. Groups in science may be organised by ability (mixed or similar ability), age, friendship or other criteria. Group work is organised so as to promote cooperation and effective learning and understanding. Every effort is made to ensure that work is carefully differentiated and matched to each group.

Teaching aims for all pupils to meet the following national curriculum targets:

- 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

- To be equipped with the scientific skills required to understand the uses and implications of science, today and for the future. We understand that it is important for lessons to have a skills-based focus, and that the knowledge can be taught through this.

We encourage pupils to be inquisitive throughout their time at the school and beyond. The science curriculum fosters a healthy curiosity in pupils about our universe and promotes respect for the living and non-living. We believe science encompasses the acquisition of knowledge, concepts, skills and positive attitudes.

Throughout the programmes of study, pupils will acquire and develop the key knowledge that has been identified within each unit and across each year group, as well as the application of scientific skills.

We ensure that the *Working Scientifically* skills are built-on and developed throughout pupils' time at the school so that they can apply their knowledge of science when using equipment, conducting experiments, building arguments and explaining concepts confidently and continue to ask questions and be curious about their surroundings.

Key Stage 1

The principal focus of science teaching in Key Stage 1 is to enable pupils to experience and observe phenomena, looking more closely at the natural and humanly-constructed world around them. They are encouraged to be curious and ask questions about what they notice. They are helped to develop their understanding of scientific ideas by using different types of scientific enquiry to answer their own questions, including observing changes over a period of time, noticing patterns, grouping and classifying things, carrying out simple comparative tests, and finding things out using secondary sources of information. They begin to use simple scientific language to talk about what they have found out and communicate their ideas to a range of audiences in a variety of ways. Most of the learning about science is through the use of first-hand practical experiences, but there is also some use of appropriate secondary sources, such as books, photographs and videos.

Working Scientifically is described separately in the programme of study, but must always be taught through, and clearly related to, the teaching of substantive science content in the programme of study. Throughout the notes and guidance, examples show how scientific methods and skills might be linked to specific elements of the content.

Pupils should read and spell scientific vocabulary at a level consistent with their increasing word reading and spelling knowledge at Key Stage 1.

Lower Key Stage 2

The principal focus of science teaching in lower key stage 2 is to enable pupils to broaden their scientific view of the world around them. They do this through exploring, talking about, testing and developing ideas about everyday phenomena and the relationships between living things and familiar environments, and by beginning to develop their ideas about functions, relationships and interactions. They ask their own questions about what they observe and make some decisions about which types of scientific enquiry are likely to be the best ways of answering them, including observing changes over time, noticing patterns, grouping and classifying things, carrying out simple comparative and fair tests and finding things out using secondary sources of information. They are taught to draw simple conclusions and use some scientific language, first, to talk about and, later, to write about, what they have found out.

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. Throughout the notes and guidance, examples show how scientific methods and skills might be linked to specific elements of the content.

Pupils should read and spell scientific vocabulary correctly and with confidence, using their growing word reading and spelling knowledge.

Upper Key Stage 2

The principal focus of science teaching in upper key stage 2 is to enable pupils to develop a deeper understanding of a wide range of scientific ideas. They do this through exploring and talking about their ideas; asking their own questions about scientific phenomena; and analysing functions, relationships and interactions more systematically. At upper key stage 2, pupils encounter more abstract ideas and begin to recognise how these ideas help them to understand and predict how the world operates. They also begin to recognise that scientific ideas change and develop over time. Pupils are taught to select the most appropriate ways to answer science questions using different types of scientific enquiry, including observing changes over different periods of time, noticing patterns, grouping and classifying things, carrying out comparative and fair tests and finding things out using a wide range of secondary sources of information. Pupils begin to draw conclusions based on their data and observations, use evidence to justify their ideas, and use their scientific knowledge and understanding to explain their findings.

Working and Thinking 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. Throughout the notes and guidance, examples show how scientific methods and skills might be linked to specific elements of the content.

Pupils should read, spell and pronounce scientific vocabulary correctly.

Organisation

Science Topics

Year Group	Topic – Autumn	Topic - Spring	Topic - Summer
Reception	Knowledge and Understanding of the World (see medium term plans)	Knowledge and Understanding of the World	Knowledge and Understanding of the World
Year 1 Prep 2	Seasonal changes Everyday materials	Seasonal changes Animals including humans (Identify animals, draw and label human body)	Seasonal changes Plants
Year 2 Lower Transitus	Habitats Everyday materials	Plants Animals including humans - Growth and Survival	Animals including humans - Growth and Survival Super Scientists

Year 3 Upper Transitus	Forces and Magnets Animals including humans (Nutrition, Skeletons and muscles for support, protection and movement)	Rocks and Soils Plants	Light Animals including humans
Year 4 F.1.	Electricity Sound	Animals including humans (Digestive System, teeth, food chains)	Living things and their habitats (Classification keys) States of Matter
Year 5 F.2.	Materials Living things (Life-cycles)	Earth and Space Animals including humans (Describe changes as humans develop to old age)	Forces Materials
Year 6 F.3.	Living things and their habitat Animals including humans (Circulatory system)	Light Electricity	Evolution and inheritance Animals including humans

<u>Key Stage 2 to Key Stage 3 transition</u>

Specialist teachers from the Senior school are deployed in the Prep. School once a week as part of the transition programme. This enables the Prep and Senior School teachers to develop a stronger understanding of pupils' learning at both key stages 2 and 3. The science transition programme is designed to aid in the development of skills, followed by the learning of scientific theory. The vehicle to do so is carrying out exciting experiments, such as Lavoisier's work on discovering the gases of the atmosphere.

Pupils also complete the British Science Association CREST awards. The work enables the prep school pupils to undertake projects in science, technology, engineering and maths (STEM) related ideas. Pupils achievements are then recognised with awards at Star (F2) and Superstar (F3) levels. When the same pupils join the Senior school, they carry on with the scheme by completing work for the Discovery (1st Form), Bronze (2nd Form), Silver (3rd Form) and Gold awards (GCSE, and GCE). In this way, pupils are prepared for further project work, such as Extended Project Qualifications.

The Prep school teachers for F2 and F3 liaise with teachers at the Senior school once a week when we deliver the science transition activities. Additionally, the Prep. School science coordinator regularly liaises with the HoD at the Senior School.

To enable the formation of a transition ethos in the department and to help teachers appreciate its importance, the science transition is timetabled and the majority of Senior School teachers are involved in its delivery.

The curriculum has been carefully planned and is constantly evolving to cater for the needs of our pupils and ensure smooth transition from one key stage to the next. The transition science programme puts emphasis on the development of scientific inquiry skills; they make an excellent companion to an outstanding academic knowledge.

Examples:

The collection of the **F2 & F3 transition activities** allows pupils to explore every day problems using science.

In **F2**, 'Animal Adventure' is designed to get pupils thinking about minibeasts and habitats. They need to **go in the field**, **observe and use keys to identify** organisms, **learn how to share** their **findings** with the rest of the group. 'Brilliant Bubbles' is designed to get pupils thinking about liquids, gases, and bubbles. They need to **carry out** their **own tests** to make different shaped, sized, colour bubbles. 'Music Maker' is designed to get pupils **using their imagination to visualise** how particles behave for sound to be produced. They need to think about why a bottle makes different sounds, **test** different amounts of water in bottles and **observe** how they change the sound, **record** their results and **present** them to the **group**. 'Plant Detectives' is designed to get pupils thinking about where plants grow. They need to **investigate** and **discover** plants in their surroundings, **work out** how plants got to where they grow, **record** their results and **present** them in an **album or poster**. 'Useless Umbrella' is designed to get pupils thinking about materials and their water resistance. They need to **design** an experiment to **test** how waterproof different materials are. They **carry out their own experiment** and **observe** what happens. Finally, they **decide** on the best material for an umbrella and **share** their **ideas**.

In **F3**, 'Band Rollers' is designed to get pupils thinking about **design**, energy, forces and motion. Thy need to **create** their own wind up band roller, **compare** the speed and duration of their different band rollers, **log** and **share** their results **reflecting on** how they could **improve** their **design**. 'Cheesy Challenge' is designed to get pupils thinking about how milk is changed into cheese. They need to **make** their own cheese and **research** other milk products. 'Crafty Rafts' is designed to get pupils **designing** and **making** a raft that floats. They need to make the raft using just a piece of paper. They need to conduct a '**fair test**' to see which raft design can hold the most weight. 'Get Set Jellies' is designed to get pupils **making** and **testing** different jelly recipes. They need to use different types of fruit, **record** their results, **produce a guide** to making fruit jelly. 'Kite Calamity' is designed to get pupils to **make** a model kite that will fly. They need to **test** models to come up with the kite of their **own design** that will fly the best. 'Racing Rockets' is designed to get pupils to think about rocket **designs** and **build** a rocket that can go as high as possible. They need to think about different shapes and sizes of rockets, **test** them, **share** their **findings** with the rest of the group.

'Super Spinners' is designed to get pupils **thinking about** helicopter blades, and how different blade sizes change the way a paper spinner falls.

In summary, before the Prep school pupils join the Senior school, they develop the following skills:

1. Field investigations
2. Observe and record
3. Use a 'Key' to identify unknown organisms
4. Learn how to share findings
5. Carry out own tests
6. Use imagination to visualise an abstract concept
7. Design, make and test
8. Test to improve design
9. Present in an album or poster
10. Present to a group
11. Communicate findings in a conversation

Key Stage 3

Topics taught:

1st Form topics

1. Cells
2. Body systems
3. Reproduction
4. Particles and their behaviour
5. Elements, Atoms & Compounds
6. Reactions
7. Acids and alkalis
8. Forces
9. Sound
10. Light
11. Space

2nd Form topics

12. Health & Lifestyle
13. Ecosystem processes
14. Adaptation & inheritance
15. The Periodic Table
16. Separation techniques
17. Metals & Acids
18. The Earth
19. Electricity and magnetism
20. Energy
21. Motion and pressure

3rd Form topics

Biology

22. New technology
23. Turning points
24. Detection

Chemistry

25. New technology
26. Turning points
27. Detection

Physics

28. New technology
29. Turning points
30. Detection

We teach the '*Activate 1, 2, 3*' schemes of work due to their holistic approach to science education, which matches the department's approach. This has been proved to be the best preparation for the delivery of the separate science courses at G.C.S.E. since a number of KS4 topics overlap between the separate sciences, for example how ionising radiation (Physics) affects the rate of mutations (Biology)
The assessment model is based on three bands:

- *Secure*
- *Developing*
- *Extending*

The bands are matched to the **new national curriculum statements**. The middle band indicates that pupils have a *secure* grasp of the content and skills specified in the Programme of Study. The band working towards secure is *developing*, and the band moving past secure is *extending*. Maths, literacy and working scientifically skills are embedded throughout, with progression of skills carefully planned, and supported by tasks and assessments to help monitor progress.

***Examples*:**

'Using Models' is designed to provide ideas for **developing a sequence** of cell **models** to **explore** how cells can form tissues and organs. The pupils need to **discuss** what each part of the model represents and **relate** it to what can be seen under the microscope so that when they view their own slides of cells they are better prepared to understand what they are looking at. 'Make your own Indicator' gets pupils to **investigate** a range of different plant material to find out how effective they are indicating if a substance is acidic, alkaline or neutral. They **compare** the indicators they **made themselves** to the other typical laboratory indicators, for example, litmus. 'Balancing a Beam' is designed for pupils to get the real feeling of how moments work. The pupils need to **prepare** a beam and **place** paper clips on it **accurately** so that it is balanced. They will then **design** their own results table and **discuss** how many times the measurements should be made and **what units** they are in.

In summary, at KS3 the pupils develop the following skills:

1. Be objective, accurate and precise.
2. Distinguish between repeatability and reproducibility.
3. Explain why new models are needed.
4. Explain the importance of peer review.
5. Ask questions to develop a line of enquiry based on prior knowledge, experience and observations.
6. Make predictions and develop them into hypotheses using scientific knowledge an understanding.
7. Select, plan and carry out appropriate activities to test predictions.
8. Identify independent, dependent and control variables when designing practical work.
9. Use appropriate techniques, apparatus, and materials during fieldwork.
10. Follow risk assessments to carry out lab and field work safely.
11. Make and record observations and measurements using a range of methods for different investigations.
12. Evaluate the reliability of methods and suggest how to make them more reliable.
13. Evaluate qualitative and quantitative data.
14. Apply mathematical concepts and calculate results.
15. Present results using appropriate tables and graphs.
16. Interpret graphs to identify patterns.
17. Use data acquired from experiments to carry out further calculations.
18. Use data from observations and relevant topic knowledge to make conclusions.
19. Understand and use correctly and consistently Standard Internation (SI) units.

Key Stage 4

Topics taught:

G.C.S.E. Biology

1. Cell Biology
2. Organisation
3. Infection and response
4. Bioenergetics
5. Homeostasis and response
6. Inheritance, Variation and evolution
7. Ecology

G.C.S.E. Chemistry

1. Atomic structure and the periodic table
2. Bonding, structure and the properties of matter
3. Quantitative chemistry
4. Chemical changes
5. Energy changes
6. The rate and extent of chemical change
7. Organic chemistry
8. Chemical analysis
9. Chemistry of the atmosphere
10. Using resources

G.C.S.E. Physics

1. Energy
2. Electricity
3. Particle model of matter
4. Atomic structure
5. Forces
6. Waves
7. Magnetism/Electromagnetism
8. Space physics

All three main sciences are taught as separate sciences at Key stage 4. The science teaching is a continuation of ideas and skills developed in earlier key stages in the subject disciplines of biology, chemistry and physics. It is designed to provide a platform for outstanding exam results as well as science enrichment (CREST, Level 1 and Level 2 AQA Projects) and transition to Key stage 5 through the teacher guided while at the same time more independent project work.

The work allows all pupils to develop the following skills (see **examples** in brackets):

1. Use of **models to explain new theories** which are the result of new discoveries, (e.g. moving from the '*plum pudding*' model of the atom to the '*nuclear*' model).

2. Assume that c**orrelation does not necessarily mean causation**. There may be a number of causes for every effect (e.g. smoking is not the only cause of lung cancer despite of the strong correlation between the two).

3. Different organisms/objects and **systems interact to cause change** (e.g. how colder outside temperatures result in vasoconstriction to help maintain a normal body temperature).

4. **Follow a complex protocol accurately** to carry out all required practical work to appreciate that science progresses through a cycle of hypothesis, practical experimentation, observation, theory development and review (e.g. carrying out experiments to see if a coil of wire has a stronger magnetic field than a straight wire when both carry the same electric current. Then, investigate the number of coils and voltage/current as the independent variables while in the process ensuring all relevant control variables are considered. Use the possible motion of the wire to develop your own theory of what makes d.c. motors spin).

5. **Use and compare analogue and digital technologies** (e.g. digital thermometers being more accurate and quick and how they reduce the possibility of random errors).

6. Learn to **apply observational, practical, modelling, enquiry, problem-solving skills and mathematical skills**, both in the laboratory, in the field and in other environments.

7. **Evaluate** claims based on science through **critical analysis** of the methodology, evidence and conclusions, both qualitatively and quantitatively (e.g. evaluate the use of stem cells from a patient's own bone marrow instead of stem cells from an embryo based on methods used to acquire the stem cells and data provided for their therapeutic effectiveness).

8. Appreciating the power and **limitations** of science and considering **ethical** issues which may arise (e.g. the further development and use of nuclear power to meet the world's energy needs).

9. Recognising the importance of **peer review** of results and of **communication** of results to a range of audiences (e.g. how vaccines are developed and how the public is persuaded to use them).

10. Carrying out experiments appropriately as a follow up to **developing hypotheses**. The experiments need to have due regard to the **correct manipulation of apparatus**, the accuracy of measurements and health and safety considerations (e.g. carry out titrations, using graduated pipettes to measure pre-determined volumes and burettes to measure previously unknown volumes to calculate concentrations).

11. Presenting **reasoned conclusions**, including relating data to hypotheses and based on the interpretation of tables of results and graphs (e.g. how the length of a wire affects its resistance).

12. **Identify** potential **sources** of random and systematic **error** (e.g. in Hooke's Law investigations).

In addition all topics for each science and all required practical activities are delivered following the exam board's practical protocols.

Key Stage 5

Topics taught:

G.C.E. Biology

1. Biological molecules
2. Cells
3. Organisms exchange substances with their environment
4. Genetic information, variation and relationships between organisms
5. Energy transfers in and between organisms
6. organisms respond to changes in their internal and external environments
7. Genetics, populations, evolution and ecosystems
8. The control of gene expression

G.C.E. Chemistry

1. Atomic structure
2. Amount of substance
3. Bonding
4. Energetics
5. Kinetics
6. Chemical equilibria
7. Redox
8. Thermodynamics
9. Rate equations
10. Electrochemistry
11. Acids and bases
12. Periodicity
13. Reactions of ions in aqueous solutions
14. Organic chemistry
15. Organic analysis

G.C.E. Physics

1. Measurements and their errors
2. Particles and radiation
3. Waves
4. Mechanics and materials
5. Electricity
6. Further mechanics and thermal physics
7. Fields and their consequences
8. Nuclear physics
9. Astrophysics
10. Medical physics
11. Engineering physics
12. Turning points in physics
13. Electronics

The A level Biology, Chemistry, Physics courses are assessed by exams only. A second qualification linked to each course, the Practical Endorsement, is delivered and assessed in parallel with each A Level throughout the two years. The Practical Endorsement tests essential practical skills.

Also, all students are offered the AS qualifications, which are designed to be taught alongside the first year of A Levels.

All A Level students of the sciences are taught the respective topics above for their chosen A Level(s) and develop the following skills when completing the practical endorsement:

1. Correctly **follow written instructions** to carry out experimental protocols (e.g. use a signal generator and oscilloscope to generate and measure waves, using microphone and loudspeaker, or ripple tank, or vibration transducer).

2. Correctly use selected instruments, apparatus and materials to carry out investigative activities, experimental techniques and procedures with **minimal assistance** or prompting (e.g. using burettes and pipettes to carry out titrations or setting up glassware using retort stand and clamps to carry out distillation and heat under reflux).

3. **Identify practical issues** and **making adjustments when necessary** (e.g. adjust the optical microscope to identify the stages of mitosis in stained squashes and calculate the mitotic index).

4. **Control significant variables** in investigations and take measures to **minimise** the **effect** of **variables that can not be controlled** (e.g. measure the EMF of an electrochemical cell, controlling the concentrations of the solutions used and accounting for the small difference in the resistance of the wire used as a result of its temperature changing during the course of the experiment).

5. **Select appropriate equipment** to ensure the recording of **accurate results** (e.g. using the melting point apparatus to decide if the solid product by crystallisation is pure or impure).

6. **Carry out full risk assessments** that include the hazards and the risks associated with each hazard as well as control measures, what to do in case of an accident and level of risk (e.g. when using microbiological aseptic techniques to grow safely in the school lab potentially harmful bacteria).

7. **Use appropriate standard international units** to record relevant, accurate, precise and sufficient data from experimental and investigative procedures (e.g. when determining the resistivity of a wire using a micrometer, ammeter, and voltmeter).

8. **Use appropriate software** to **carry out research** and **report findings** (e.g. when investigating using a search coil and oscilloscope, the effect on magnetic flux linkage of varying the angle between a search coil and magnetic field direction).

9. **Cites sources** of information demonstrating that **research** has taken place, supporting planning and conclusions (e.g. when investigating the effect of an environmental variable, such as humidity and brightness, on the rate and direction of movement of a small animal).

Journey & Endpoints

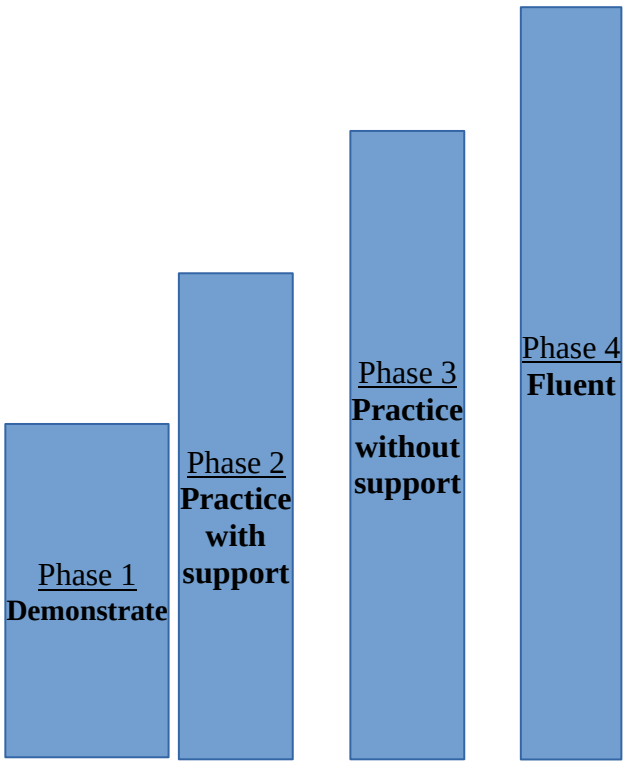
Progression in topics is shown by the respective specifications of the courses delivered. Progression in the mastery of scientific inquiry skills shows increasing independence and confidence:

Phase 1. Demonstrate (KS2, early KS3): ***'teacher shows me and I copy'***

Phase 2. Practice with support (KS3): '***I can do it myself but I may need to ask my teacher every now and again and if it goes wrong I am stuck'***

Phase 3, Practice without support (KS4): ***'I can have a go and get quite a way without any support or guidance, but there are times when I might need to check a few details'***

Phase 4, Fluent (late KS4, KS5): ***'No problem! I can help my friends if necessary'***



Implementation

Key Stages 1 and 2

Teachers create a positive attitude to science learning within their classrooms and reinforce an expectation that all pupils are capable of achieving high standards in science. Our whole-school approach to the teaching and learning of science involves the following:

1. Science is taught in planned blocks by the class teacher, to enable the achievement of a greater depth of knowledge.

2. Through our planning, we involve problem solving opportunities that allow pupils to apply their knowledge, and find out answers for themselves. Pupils are encouraged to ask their own questions and be given opportunities to use their scientific skills and research to discover the answers. Planning involves teachers creating engaging lessons, often involving high-quality resources to aid understanding of conceptual knowledge. Teachers use precise questioning in class to test conceptual knowledge and skills, and assess pupils regularly to identify those pupils with gaps in learning, so that all pupils keep up.

3. We build upon the knowledge and skill development of the previous years. As the pupils' knowledge and understanding increases, and they become more proficient in selecting, using scientific equipment, collating and interpreting results, they become increasingly confident in their growing ability to come to

conclusions based on real evidence.

4. Working Scientifically skills are embedded into lessons to ensure these skills are being developed throughout the pupils' school career and new vocabulary and challenging concepts are introduced through direct teaching. This is developed through the years, in-keeping with the topics.

5. Teachers demonstrate how to use scientific equipment, and the various Working Scientifically skills in order to embed scientific understanding. Teachers find opportunities to develop pupils' understanding of their surroundings by accessing outdoor learning and workshops with experts.

6. Pupils are offered a wide range of extra-curricular activities, visits, trips and visitors to complement and broaden their curriculum knowledge.

Key Stages 3, 4 & 5

1. **Modelling**: Science teachers show how to do something, such as how to calculate the relative formula mass of a compound. Then, they invite all learners to do a calculation with the teacher. Then learners do a similar task on their own.

2. **Visual tools**: Science teachers use interactive whiteboards to show information or the connection between ideas in the form of Venn diagrams or flow charts.

3. **One-on-one and small group instruction**: Some lessons are taught to the whole class. Others are better for a small group of pupils/students. Placing learners into small groups helps with differentiation and intervention.

4. **Thinking time**: A few seconds pause after asking a questions. Instead of calling on the first pupils/students that raise their hands we stop and wait for a few seconds. This allows our learners to understand what the teacher asked and to think of a response.

5. **Free writing using key words to answer learning objectives**: The learning objectives are used in summaries in which pupils/students use the key words identified during the lesson to produce written responses that meet the questions the learning objectives create.

Classroom assessment

1. Identifying prior knowledge
2. Identifying and clear misconceptions
3. Using mini plenaries and plenaries to check learning during and at the end of the lesson
4. Providing effective verbal and written feedback to learners responses and work to move learning forwards

Assessment for learning

5. Using past paper questions in class and term/end of year/mock tests/exams to assess learning and provide written feedback to explain how the mark scheme works and move learning forwards

Consolidation of key concepts and their application to real-life problems

1. **Focusing learners attention** by creating a working purposeful atmosphere in class.
2. **Avoiding cramming** by breaking down topics into small parts that are delivered in a logical sequence.
3. **Structuring and organising** by grouping similar concepts and terms together by following the delivery of principles and topics as indicated by the schemes of work.
4. **Using mnemonics** that use imagery, humour, or novelty as a positive technique to aid recall.
5. **Visualising concepts** by using photographs, charts, and other graphics in textbooks and on class screens.
6. **Relating new information to prior knowledge** by establishing relationships between new ideas and previously existing memories/knowledge.
7. Pupils/students are encouraged to **explain** their findings **loud in class**, which enhances understanding and recall.

Impact

Key Stages 1 and 2

Science is outstanding when:

1. Pupils apply their 'working scientifically skills' to solve problems, explore, observe and investigate.

2. Pupils ask questions and work together to discover the answers.

3. Science has a 'wow' factor and promotes a sense of awe and wonder.

4. Our learning is enhanced by outdoor learning, specialist visitors and we have access to quality resources.

5. Pupils are involved in creating and carrying out investigations and can share and explain our ideas and conclusions These posters are on display on the working wall in science and referred to throughout the coverage of each science topic.

6. Pupils are encouraged to ask their own questions and be given opportunities to use their scientific skills and research to discover the answers. This curiosity

is celebrated within the classroom.

7. Teachers ask a range of questions which enable all pupils to take part, listening carefully to answers and taking learning forward, using open and closed questions and allowing pupils time to think.

8. Planning involves teachers creating engaging lessons, often involving high-quality resources to aid understanding of conceptual knowledge.

9. Teachers use precise questioning in class to test conceptual knowledge and skills, and assess pupils regularly to identify those pupils with gaps in learning, so that all pupils keep up.

10. New vocabulary and challenging concepts are introduced through direct teaching. This is developed through the years, in-keeping with the topics.

11. *Working Scientifically* skills are embedded into lessons to ensure these skills are being developed throughout the pupils' school career. The key knowledge for each topic and across each year group is mapped across the school and checked at the end of each science topic.

12. Teachers demonstrate how to use scientific equipment, and the various *Working Scientifically* skills in order to embed scientific understanding.

13. Teachers find opportunities to develop pupils' understanding by accessing outdoor learning. Scientific knowledge and conceptual understanding.

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. Pupils' starting points are identified at the beginning of each science topic and the pupils are able to convey and record what they know already. At the end of the block, pupils' knowledge is checked in line with the key knowledge identified prior to the teaching block.

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 and teachers ensure that this is developed within each lesson and throughout each science topic. The science curriculum ensures that pupils are provided with regular opportunities to apply their mathematical knowledge to their understanding of science, including collecting, presenting and analysing data. The pupils are also able to suggest what they would like to learn at the start of each teaching sequence and this ensures that teachers are able to adapt the programme of study to ensure that this is informed by pupils' interests and to maximise their engagement with and motivation to study science.

The nature, processes and methods of science

Working Scientifically specifies the understanding of the nature, processes and methods of science for each year group and this is embedded within lessons and focuses on the key features of scientific enquiry, so that pupils learn to use a variety of approaches to answer relevant scientific questions. These types of scientific enquiry include: observing over time; pattern seeking; identifying, classifying and grouping; comparative and fair testing (controlled investigations); and researching using secondary sources. Pupils are given opportunity to seek answers to questions through collecting, analysing and presenting data.

Spoken language

The national curriculum for science reflects the importance of spoken language in pupils' development across the whole curriculum – cognitively, socially and linguistically. At St. John's Prep School science lessons provide a quality and variety of subject specific language to enable the development of pupils' confident and accurate use of scientific vocabulary and their ability to articulate scientific concepts clearly and precisely. They are encouraged and assisted in making their thinking clear, both to themselves and others, and teachers ensure that pupils build secure foundations by using discussion to probing and remedying their misconceptions.

Assessment

Pupils' progress is continually monitored throughout their time at St. John's Prep School and is used to inform future teaching and learning. By the end of each key stage, pupils are expected to know, apply and understand the matters, skills and processes specified in the relevant programme of study as set out in the National Curriculum. These are set out as statutory requirements. We also draw on the non-statutory requirements to extend our pupils and provide an appropriate level of challenge.

Pupils receive effective feedback through teacher assessment, both orally and through written feedback in line with the success criteria. Pupils are guided towards achievement of the main objective provided by and explained by the teacher.

Assessment for learning is continuous throughout the planning, teaching and learning cycle. However, pupils are more formally assessed half termly in KS1 and KS2 using a variety of methods:

1. Observing pupils at work, individually, in pairs, in a group, and in classes.

2. Questioning, talking and listening to pupils.

3. Considering work/materials/investigations produced by pupils together with discussion about this with them. At the start of a new topic, the pupils identify what they know already about each topic, as well as what they would like to know. The programme of study takes is responsive to the pupils' starting points, as well as their specific interests. It also ensures a focus on the key identified knowledge of each topic, which is mapped within and across year groups to ensure progression.

At the end of each blocked science topic, this key knowledge is checked. Outcomes of work also evidence its acquisition.

In EYFS, we assess the pupils' Understanding of the World according to the Development Matters statements and some aspects of Expressive Arts Design are also science based.

Planning and resources

Planning is a process in which all teachers are involved. All teachers keep a copy of the termly planning in their files. We use the National Curriculum for Science to inform teachers' planning. The key knowledge and skills of each science topic is also informed by using Twinkl, STEM or PlanBee.

Further evidence of 'outstanding science' taking place in classrooms includes:

1. Pupils being encouraged to ask and answer questions and discuss their work and ideas.

2. Pupils devising and conducting their own investigations within the context of the relevant curriculum content, as well as being given opportunities to develop their working scientifically skills.

3. Pupils recording their findings in a variety of ways.

4. Pupils showing enjoyment in the activities they are undertaking.

5. Cross-curricular teaching of science. We have science resources to aid and support the teaching of all units and topics taught, from EYFS to Y6. We keep these in respective classrooms or they can be borrowed from the F2 Raleigh's classroom or the Senior School. EYFS have a range of resources kept in classes, for simple access for children during exploration.

Key stages 3, 4 & 5

1. Learners **summarise** or **paraphrase** important concepts during lessons. This happens either verbally or in writing.

2. **Reflecting** in the last five to ten minutes of the lesson what was learnt. Again this can be verbal or on paper.

3. **Formative pencil-paper assessment** using '***Exampro***' questions tailored to the topic/concept taught. The questions are used as a tool to monitor progress and make learners more aware of the demands of the mark scheme. Both teachers and learners quickly **assess** whether the pupil acquired the intended knowledge and skills. This is a formative assessment so a grade is not the intended purpose.

4. **Practice frequency**, that is, check for understanding at least three times during the lesson through the effective use of **mini plenaries**.

5. **Peer instruction**, that is, ask certain pupils teach their classmates what was learnt today. Teachers can easily assess understanding by listening to pupils' explanations.

6. Asking pointed questions that require pupils to use their own prior knowledge to answer; avoiding Yes/No questions or phrases like '*does this make sense'*?

7. Using **short quizzes** to check for comprehension

8. **One question quiz**; asking a single focuses question with a specific goal that can be answered within a minute or two. Teachers, then, scan pupil responses to assess pupil understanding.

Endpoints and next stage:

1. Learning objectives are used routinely to help reaching the endpoint for each lesson. Specifications are accurately followed to reach the endpoints of all topics and courses. All science assessments test the theory as well as the scientific inquiry and practical skills developed at each key stage. A big part of each paper is made of questions that test learners on familiar concepts applied to unfamiliar contexts. Continuous assessments on theory, required practical activities and practical endorsements allow teachers to know when each learner achieves the success criteria that make them ready for the next stage.

2. The majority of 3rd form pupils take at least two sciences at GCSE with more that 50% taking three sciences at GCSE. The majority of Science GCSE pupils take at least one science at A Level. The above provides proof pupils feel confident to take science course when moving from one key stage to the next one up.

3. Series of lessons are used in the planning of a sequence of activities that helps pupils to work through from not knowing how to do something to being fluent in it and to being able to use and apply that knowledge. The required practical activities at GCSE and the practical endorsement activities at A Level are the best examples where a series of ten to twelve activities over the two-year course ensure the journey from not knowing to being fluent is completed.

Outstanding achievement (end-points)

Achievement is consistently very high. The latest KS4 and KS5 results analysis reveals the following:

2019/20 G.C.S.E.:

Subject	Entries	Expected points	Actual points	Alps score	Alps grade	Meaning
Biology	25	154.33	184	1.24	2	Outstanding
Chemistry	27	166.50	197	1.23	2	Outstanding
Physics	18	114.75	136	1.24	2	Outstanding

Subject	9- 1 (%)	9- 4 (%)	9- 5 (%)	9-7 (%)
Biology	100	100	100	64.0
Chemistry	100	100	100	70.4
Physics	100	100	100	77.8

2019/20 A Level:

Subject	Entries	Expected points	Actual points	Alps score	Alps grade	Meaning
Biology	4	362.52	460	1.24	1	Outstanding
Chemistry	3	314.85	400	1.28	1	Outstanding
Physics	9	906.75	1020	1.13	1	Outstanding

Subject	A*- E (%)	A*- C (%)	A*- B (%)
Biology	100	100	100
Chemistry	100	100	100
Physics	100	88.9	88.9

Cultural capital

The way science is taught at St. John's is to build knowledge and develop the skills our pupils can use in the future to illuminate the world around us. Often in class the ideas are modified, expanded, and combined into more powerful explanations.

Examples:

Describing the structure of DNA and explaining how it replicates and its role in protein synthesis forms the foundations of research that can ultimately lead to developing tests for genetic diseases.

Explaining how genetically engineered bacteria produce human insulin motivates many future researchers on the field to develop microorganism that cheaply produce drugs for diseases like malaria.

Explaining how CFS's and free radicals destroy the ozone layer forms the knowledge foundation that is needed to develop chemicals in the future that could be released into the upper layers of the atmosphere to remove the chemicals that destroy it.

Describing the properties of nanoparticles could lead to future nanoparticles that deliver drugs (nanorobots) within the body to kill cancers.

In addition to the classroom teaching, our pupils come across and meet leading scientists in live events. This is where the exchange of ideas and interaction with them can offer the best motivation for following a science path in the future and improve the world. The list of scientists/presenters is long and includes:

1. Professor Robert Winston; a medical doctor, distinguished scientist in the area of human fertility, well known television presenter, politician.

2. Professor Andrea Sella; he is talking about how the zebra got its stripes and performs live experiments.
3. Professor Jim Al-Khalili; famous BBC and Channel 4 presenter who has won the Faraday price for science communication.
4. Dr Maggie Aderin Pocock; presenter of the BBC's *The Sky At Night*.