# Bolton Impact Trust, Park School Science Curriculum

## Rationale

As a Trust, we believe that a high quality Science education provides a foundation for understanding the world through the specific disciplines of biology, chemistry and physics. Pupils will gain an understanding and appreciation of the ways in which science has shaped our world and the importance that science has on the world's future prosperity. Pupils will learn to think as a scientist and will develop a curiosity and interest in how science can be used to understand, analyse and predict the world we live in.

## Knowledge

We ensure that throughout the Science curriculum pupils acquire the key knowledge required to:

- Understand the specific disciplines of biology, chemistry and physics
- Develop an 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
- Understand the uses and implications of science, today and for the future

## Character

We ensure that pupils develop their own character attributes by understanding the impact that they have upon the world around them, and the responsibilities that they have as an individual but also as part of the wider society to protect their world. We encourage pupils to take part in ethical discussions and to be open and empathic to alternative viewpoints.

## Creativity

We ensure that pupils value and develop their own creativity by sharing with them the inventions, innovations and discoveries which science has made through individuals being creative in their thinking; and by doing so, have had a profound impact upon the world and our understanding of it.

## Innovative Thinking

We inspire pupils to think scientifically. To understand the importance of objectivity, accuracy, precision, repeatability and reproducibility. To evaluate risks and to understand that methods and theories develop over time as new evidence and ideas are taken into account. We encourage pupils to be curious about the world and to ask questions, to develop a passion for investigation and research and to analyse and make predictions about the world we live in.

## Transform

Pupils will transform the essential knowledge and skills that they are taught in the Science curriculum into long-lasting success in the world of further study and work. They will be equipped with a wide range of transferable skills such as problem solving, practical and numerical skills, enquiry and reasoned debate, analytical skills, scientific literacy and teamwork. Pupils will be exposed to, and will appreciate the myriad of opportunities for scientists in the modern world; particularly in the fields of health, medicine, transport, defence and security.

# Science Curriculum Design

The Science curriculum has been carefully planned and sequenced so that knowledge builds upon prior knowledge and as pupils move through the academic year and the various pathways, knowledge and understanding is deepened and regularly revisited. Our curriculum topics are planned in a way which ensures that our pupils can learn the most important key component knowledge at both key stages which build in depth and level of challenge for each term that they are with us. Knowledge and skills are repeated regularly to enable pupils to retrieve prior learning regularly, to increase their confidence, and to address the needs of the pupils who join us throughout the year and with vastly different abilities and experiences of the Science curriculum prior to joining us. Pupils who leave us to return to mainstream are able to re-engage with the Science curriculum there.

At Park school, Science is taught in small groups of up to 8 pupils by a specialist science teacher. The small class size provides a safe and nurturing environment where pupils can learn about challenging or sensitive topics such as health and diseases, human reproduction and contraception. Students may wish to speak to a member of staff about a topic being covered during the lesson, or need additional support in managing their emotions, so the role of the Learning Mentor is particularly important in science lessons.

The science offer at Park School consists of five timetabled 45 minute lessons per week. In addition, there are opportunities for teacher-led discussion of key themes during form time, as well as through the wider curriculum; particularly in PSHE and Geography. As well as giving pupils the opportunity to revisit and consolidate their learning, this also allows staff to support and advise our more vulnerable students, with areas of particular concern that arise through the school year. For example, staff may become aware particular risks to pupil physical or sexual health, which can then be addressed in a factual but supportive way.  During the summer months, students may be advised on water safety and keeping themselves safe outdoors. Form time discussion in Park School is also used to facilitate Pupil Voice, giving students the opportunity to express concerns, or request additional advice on matters relating to their science learning. These would then be addressed in science lessons, as well as contributing to future curriculum planning.

At Park School, there is a cross curricular approach to science teaching. In PSHE, students are taught about healthy lifestyles, the importance of a balanced diet and regular exercise, and the effects of drugs on health. Students further develop their knowledge of immunisation, vaccination, use of antibiotics, ethics of drug testing as well as the ethical and spiritual arguments related to organ transplants. Consideration is given to the cultural and spiritual background of our young people when delivering the science curriculum. There are opportunities to address certain elements in smaller groups, or 1:1 where appropriate, in order to respect cultural identities.

Students at Park School have the opportunity to compete First Aid training, including giving CPR, which has strong links to the biology curriculum. Students continue their science learning outside the classroom, carrying out sampling and fieldwork in the nearby park. Guest speakers have also supported the delivery of the science curriculum, with recent presentations by NHS health practitioners.

Students at Park School develop their cultural capital through appreciation of the history of science. The curriculum highlights the impact of our greatest thinkers and how scientists such as Galileo, van Helmont and Darwin took great personal risks to challenge current thinking and advance our knowledge of the natural world. Pupils are also taught about the ground-breaking work done by black and female scientists such as Rosalind Franklin, Marie Curie and Maggie Aderin-Pocock. Pupils also develop their understanding of a broad range of careers in science.

Science lessons are planned to promote reading a range of non-fiction texts linked to key science themes, including leaflets on animal testing, gene therapy and genetic modification, contraception, STIs, alcohol misuse, posters on healthy lifestyles, and text books exploring particular topics. There are also opportunities to make thematic links to fiction texts explored in English lessons. These explore issues such as race, gender identity, animal rights and relationships. As well as developing oral and debating skills, students can share views and opinions they are developing; promoting confidence and engagement in their learning.

## The Key Stage 3 Science Curriculum

In key stage 3 we have used the syllabus from AQA to inform our planning. This syllabus provides an alternative approach to KS3 content. Content is under 10 big idea headings: Forces, Electromagnetism, Energy, Waves, Matter, Reactions, Earth, Organisms, Ecosystems and Genes. Each idea contains four smaller topics: the building blocks for the big ideas. This sequence of knowledge leads to pupils developing their understanding of a big idea by beginning with simpler, more concrete topics and moving to more abstract ones as they work through the curriculum. This way of sequencing knowledge helps pupils to secure key knowledge that they can then apply to less familiar topics. We have chosen to deliver the units by starting with chemistry because this provides pupils with prerequisite knowledge of atoms as the building blocks of all living things, and how atoms react during chemical reactions that are essential for life. When planning the curriculum we have been explicit in outlining not only what pupils will **know**, but also how they will **apply** this knowledge. The AQA syllabus ensures that pupils are encouraged to think like a scientist by including opportunities for pupils to analyse, communicate, enquire and solve in every topic. We also ensure that pupils can access the science curriculum by ensuring that key subject specific vocabulary is identified and explicitly taught in every unit.

Our science curriculum covers the core knowledge and enquiry processes from each of the 10 big ideas over one academic year. Each big idea is introduced and delivered over 3-4 weeks. The knowledge and skills build in complexity and depth throughout the weeks and through personalisation every pupil is given work which challenges them and builds upon their existing knowledge. If a pupil remains our setting for more than one academic year, then they will begin the cycle again in their fourth term, but through personalisation will build upon the knowledge that they had previously acquired.
This approach means that pupils in our setting will gain substantive knowledge across the breadth of the key stage 3 science curriculum which they can build upon on their return to mainstream, and which will mean that they are able to access the key stage 4 science curriculum.

## Science Key Stage 3 Intent

| Science Key Stage 3 Curriculum | Autumn → | | Spring → | | Summer → | |
|---|---|---|---|---|---|---|
| | Half Term 1 | Half Term 2 | Half Term 1 | Half Term 2 | Half Term 1 | Half Term 2 |
| | **Introduction to science**<br><br>**Matter**<br>Particle Model<br>Separating Mixtures<br>Periodic Table<br>Elements<br>Metals & Non-metals<br><br>**Reactions**<br>Chemical changes<br>Acids and Alkalis<br><br>**Science careers** | **Reactions** *cont'd*<br>Chemical Energy<br>Types of reaction<br><br>**Earth**<br>Earth Structure<br>Universe<br>Climate<br>Earth Resources | **Forces**<br>Speed<br>Gravity<br>Contact Forces<br>Pressure<br><br>**Electromagnets**<br>Voltage and resistance<br>Current<br>Magnetism & electromagnets | **Energy**<br>Energy Costs<br>Energy Transfer<br>Work<br>Heating and cooling<br><br>**Waves**<br>Sound<br>Light<br>Wave effects<br>Wave properties | **Organisms**<br>Movement<br>Cells<br>Breathing<br>Digestion<br><br>**Ecosystem**<br>Interdependence<br>Plant reproduction | **Bioenergetics**<br>Respiration<br>Photosynthesis<br><br>**Genes**<br>Human Reproduction<br>Inheritance<br>Variation and evolution |

In order to help teachers to deliver the key stage 3 science curriculum at an appropriate level to pupils, we have produced a guide to the key substantive knowledge and disciplinary knowledge that pupils should be taught depending upon their prior knowledge and their ability. Each topic has been broken down into 4 levels:

- Entering
- Emerging
- Developing
- Securing

Each level reflects the complexity of the knowledge that should be delivered. There is no limit on how quickly pupils move through these levels during the teaching of the topic. A pupil may begin at entering and move through all 4, or may begin at developing and move to securing. The teaching will adapt to suit the needs of the pupils as they learn. Any pupil with us for longer than a year, will begin a topic at the level that they reached the year before and build from

there. If a pupil achieved 'securing' previously, our personalised approach allows us to move onto another topic or to build onto other topics where their knowledge is at a lower level.

| Matter | | Entering → | Emerging → | Developing → | Securing |
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| Particle Model | Substantive Knowledge | That everything is made of tiny particles called atoms<br><br>The three states of matter & examples | *As previous levels, plus:*<br><br>The particle model of solids, liquids and gases<br><br>The properties of the different states of matter in terms of the particle model - differences in arrangements, motion closeness of particles explaining changes of state, shape and density | *As previous levels, plus:*<br><br>Changes of state in terms of the particle model<br><br>Diffusion in terms of the particle model<br><br>Changes with temperature in motion and spacing of particles | *As previous levels, plus:*<br><br>Properties of states of matter including expansion, contraction and gas pressure<br><br>The anomaly of ice-water transition (increase in volume when water freezes)<br><br>Internal energy stored in materials |
| | Disciplinary Knowledge | Interpret observations to draw conclusions<br><br>Understand and use SI units | Understand that scientific methods and theories develop as earlier explanations are modified to take account of new evidence and ideas | Make predictions using scientific knowledge and understanding<br><br>Interpret observations and data, including identifying patterns and using observations, measurements and data to draw conclusions | Identify further questions arising from results |
| Separating Mixtures | Substantive Knowledge | Mixtures, including dissolving & basic | *As previous levels, plus:*<br><br>Dissolving & key vocabulary (solute & solvent) | *As previous levels, plus:*<br><br>Diffusion in terms of the particle model | *As previous levels, plus:*<br><br>Identification of pure substances in terms of melting & boiling points |

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| | | vocabulary (dissolve & solution)<br><br>Simple separating techniques - filtration only | The concept of a pure substance<br><br>Separating techniques - filtration & evaporation | Separating techniques - distillation and chromatography | |
| | Disciplinary Knowledge | Interpret observations to draw conclusions<br><br>use appropriate techniques, apparatus, and materials, paying attention to health and safety | Understand that scientific methods develop to take account of new ideas | Make predictions using scientific knowledge<br><br>Interpret observations and data, including identifying patterns | Identify further questions arising from results |
| Periodic Table | Substantive Knowledge | The Periodic Table is organised into groups; metals and non-metals<br><br>Basic physical and chemical properties of some elements | *As previous levels, plus:*<br><br>The Periodic Table is organised into Periods and groups; metals and non-metals | *As previous levels, plus:*<br><br>How patterns in reactions can be predicted with reference to the Periodic Table | *As previous levels, plus:*<br><br>The principles underpinning the Mendeleev Periodic Table – how Mendeleev left gaps and could make predictions on the properties unknown elements |
| | Disciplinary Knowledge | Understand that scientific theories develop as earlier explanations are modified to take account of new evidence | | Make predictions using scientific knowledge | |
| Elements | Substantive Knowledge | Identifying atoms, elements, molecules and compounds from simple particle diagrams | *As previous levels, plus:*<br><br>Describe differences between atoms, elements and compounds – scientific definitions | *As previous levels, plus:*<br><br>Describe a simple (Dalton) atomic model | *As previous levels, plus:*<br><br>Write chemical symbols and formulae for elements and compounds |

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| | | Building simple models | | | |
| | Disciplinary Knowledge | Understand that scientific theories develop as earlier explanations are modified to take account of new evidence and ideas | | Ask questions and develop a line of enquiry based on observations of the real world, alongside prior knowledge | Use and derive simple equations<br><br>Make predictions using scientific knowledge and understanding |

| **Reactions** | | **Entering** → | **Emerging** → | **Developing** → | **Securing** |
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| Metals and non-metals | Substantive Knowledge | Physical properties of metals and non-metals | *As previous levels, plus:*<br><br>Chemical properties of metals and non-metals | *As previous levels, plus:*<br><br>Chemical properties of metal and non-metal oxides | *As previous levels, plus:*<br><br>Chemical properties of metal and non-metal oxides with respect to acidity |
| | Disciplinary Knowledge | Ask questions and develop a line of enquiry based on observations of the real world, alongside prior knowledge. Make predictions using scientific knowledge and understanding | | | |
| Acids and Alkalis | Substantive Knowledge | Identifying common examples of acids and alkalis<br><br>The pH scale for measuring acidity/alkalinity; and indicators<br><br>Identify hazard symbols and some safety precautions when | *As previous levels, plus:*<br><br>Reactions of acids with metals to produce a salt plus hydrogen<br><br>How to test a gas for Hydrogen<br><br>Simple word equations for acid + metal reactions | *As previous levels, plus:*<br><br>Neutralisation reactions as reactions of acids with alkalis to produce a salt plus water<br><br>Simple word equations for Neutralisation reactions<br><br>Simple chemical equations for acid + metal reactions | *As previous levels, plus:*<br><br>Simple chemical equations for Neutralisation reactions |

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| | | working with acids & alkalis | | | |
| | Disciplinary Knowledge | Use appropriate techniques, apparatus, and materials during laboratory work, paying attention to health and safety | Make and record observations and evaluate the reliability of methods | Use and derive simple equations<br><br>Make predictions using scientific knowledge and understanding | Ask questions based on observations of the real world, alongside prior knowledge |
| Chemical Energy | Substantive Knowledge | | | Energy changes on changes of state (qualitative) | *As previous levels, plus:*<br><br>Exothermic and endothermic chemical reactions (qualitative) |
| | Disciplinary Knowledge | | | Ask questions based on observations of the real world, alongside prior knowledge | |
| Types of reaction | Substantive Knowledge | Difference between chemical reactions and physical changes<br><br>Identifying reactants and products in a simple reaction | *As previous levels, plus:*<br><br>Chemical reactions as the rearrangement of atoms (reactants) to form products<br><br>Representing chemical reactions using simple word equations<br><br>Combustion reactions | *As previous levels, plus:*<br><br>Representing chemical reactions using formulae in equations<br><br>Conservation of mass in chemical reactions<br><br>Thermal decomposition and oxidation reactions<br><br>The order of metals and carbon in the reactivity series | *As previous levels, plus:*<br><br>Balancing simple chemical equations<br><br>Displacement reactions<br><br>Role of catalysts in chemical reactions and importance in industry<br><br>The use of carbon in obtaining metals from metal oxides<br><br>Properties of ceramics, polymers and composites |

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| | Disciplinary Knowledge | Use appropriate techniques, apparatus, and materials during 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 | Use and derive simple equations<br><br>Make predictions using scientific knowledge and understanding | Ask questions based on observations of the real world, alongside prior knowledge |

| **Earth** | | **Entering** → | **Emerging** → | **Developing** → | **Securing** |
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| Earth Structure | Substantive Knowledge | The 4 part structure of the Earth | *As previous levels, plus:*<br><br>The composition of the Earth in terms of elements e.g. Iron & Nickel | *As previous levels, plus:*<br><br>The rock cycle and the formation of igneous, sedimentary and metamorphic rocks | *As previous levels, plus:*<br><br>Basic idea of plate tectonics *(Geography curriculum link)* |
| | Disciplinary Knowledge | Understand that scientific theories develop as earlier explanations are modified to take account of new evidence | | | The importance of publishing results and peer review |
| Universe | Substantive Knowledge | The scale of the Universe<br><br>The structure of the solar system<br><br>Earth's rotation and days length. Earth's orbit around the Sun and year length – leap years | *As previous levels, plus:*<br><br>The seasons and the Earth's tilt, day length at different times of year, in different hemispheres<br><br>Gravity different on other planets and stars; gravity forces between Earth and Moon, and between Earth and Sun (qualitative only) | *As previous levels, plus:*<br><br>Gravity force (weight) = mass x gravitational field strength (g), on Earth g=10 N/kg, | *As previous levels, plus:*<br><br>The light year as a unit of astronomical distance - mathematical conversion to km |

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| | | Our Sun as a star, other stars in our galaxy, other galaxies | | | |
| | Disciplinary Knowledge | Understand that scientific theories develop as earlier explanations are modified to take account of new evidence and ideas | | Apply mathematical concepts and calculate results. Understand and use SI units<br><br>Present observations and data using tables and graphs | Interpret observations and data, including identifying patterns and using observations, to draw conclusions.<br><br>Present explanations in relation to predictions and hypotheses |
| Climate | Substantive Knowledge | | *As previous levels, plus:*<br><br>Composition of the atmosphere | *As previous levels, plus:*<br><br>The evolution of Earth's atmosphere<br><br>The production of carbon dioxide by human activity and the predicted impact on climate | *As previous levels, plus:*<br><br>The carbon cycle<br><br>Consequences of climate change<br><br>The integrity of scientific data on climate change and human impact |
| | Disciplinary Knowledge | | Understand that scientific theories develop as earlier explanations are modified to take account of new evidence and ideas<br><br>The importance of publishing results and peer review | | |
| Earth's Resources | Substantive Knowledge | Earth as a source of useful resources | *As previous levels, plus:*<br><br>Earth's resources are limited<br><br>Sustainability and the importance of recycling. Problems with using plastics | *As previous levels, plus:*<br><br>Consequences of dependence on fossils fuels and overuse of plastics | *As previous levels, plus:*<br><br>The efficacy of recycling – is it working? |

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| | Disciplinary Knowledge | Understand and use SI units<br><br>Present observations and data using tables and graphs | Apply mathematical concepts and calculate results | Make predictions using scientific knowledge | Ask questions based on observations and prior knowledge |

| Forces | | Entering → | Emerging → | Developing → | Securing |
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| Speed | Substantive Knowledge | Relative speed of fast & slow objects – exploring the meaning of speed | *As previous levels, plus:*<br><br>The quantitative relationship between average speed, distance and time (speed = distance ÷ time) & correct units | *As previous levels, plus:*<br><br>The representation of a journey on a distance-time graph<br><br>Forces being needed to cause objects to stop or start moving, or to change their speed or direction of motion (qualitative only)<br><br>Change in motion depending on direction of force and its size | *As previous levels, plus:*<br><br>Acceleration as the change in speed over time & correct units |
| | Disciplinary Knowledge | Understand and use SI units<br><br>Present observations and data using tables and graphs | Apply mathematical concepts and calculate results | Make predictions using scientific knowledge | Ask questions based on observations and prior knowledge |
| Gravity | Substantive Knowledge | How gravity was discovered | *As previous levels, plus:*<br><br>Gravity different on other planets and stars; gravity | *As previous levels, plus:*<br><br>Gravity force (weight) = mass x gravitational field | *As previous levels, plus:*<br><br>The nature of gravity as a very weak force, yet one |

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| | | | forces between Earth and Moon, and between Earth and Sun (qualitative only) | strength (g), on Earth g=10 N/kg | which we experience daily<br><br>How gravitational force changes with distance (inverse-square law) |
| | Disciplinary Knowledge | Understand that scientific theories develop as earlier explanations are modified to take account of new evidence and ideas | The importance of publishing results and peer review | Understand and use SI units. Present observations and data using tables and graphs. Apply mathematical concepts and calculate results.<br><br>Make predictions using scientific knowledge | Ask questions based on observations and prior knowledge |
| Contact Forces | Substantive Knowledge | Forces as pushes or pulls, arising from the interaction between two objects<br><br>Using force arrows in diagrams, adding forces in one dimension<br><br>deforming objects; stretching and squashing a spring<br><br>Friction between surfaces<br><br>Forces measured in newtons | *As previous levels, plus:*<br><br>Resistance to motion of air and water<br><br>Balanced and unbalanced forces<br><br>Non-contact forces: gravity forces acting at a distance on Earth and in space, forces between magnets and forces due to static electricity | *As previous levels, plus:*<br><br>Measurements of stretch or compression as force is changed<br><br>Opposing forces and equilibrium: weight held by stretched spring or supported on a compressed surface | *As previous levels, plus:*<br><br>Moment as the turning effect of a force<br><br>Force-extension linear relation; Hooke's Law as a special case<br><br>Work done and energy changes on deformation |

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| | Disciplinary Knowledge | Use SI units. Present data using tables and graphs. | Make and record observations<br><br>Make predictions using scientific knowledge | Select, plan and carry out the most appropriate types of scientific enquiries to test predictions, including identifying independent, dependent and control variables<br><br>Use appropriate techniques, apparatus, and materials during laboratory work, paying attention to health and safety<br><br>Make and record measurements. Evaluate the reliability of methods and suggest improvements Apply mathematical concepts and calculate results. | |
| Pressure | Substantive Knowledge | Floating and sinking | *As previous levels, plus:*<br><br>Pressure in liquids, increases with depth; upthrust effects | *As previous levels, plus:*<br><br>Atmospheric pressure, decreases with increase of height | *As previous levels, plus:*<br><br>Pressure as force over area – acting normal to any surface |
| | Disciplinary Knowledge | Use SI units. Present data using tables and graphs | Make and record observations. Make predictions using scientific knowledge. Apply mathematical concepts and calculate results. | | |

| **Electromagnets** | | **Entering** → | **Emerging** → | **Developing** → | **Securing** |
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| Voltage and resistance | Substantive Knowledge | | Potential difference, measured in volts | *As previous levels, plus:*<br><br>Separation of positive or negative charges when objects are rubbed together: transfer of electrons, forces between charged objects | *As previous levels, plus:*<br><br>Battery and bulb ratings; resistance, measured in ohms, as the ratio of potential difference (p.d.) to current<br><br>Differences in resistance between conducting and |

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| | | | | The idea of electric field, forces acting across the space between objects not in contact | insulating components (quantitative) |
| | Disciplinary Knowledge | | Use SI units. Make and record observations | Ask questions based on observations and prior knowledge | Make predictions using scientific knowledge |
| Current | Substantive Knowledge | | Electric current, measured in amperes, in circuits | *As previous levels, plus:*<br><br>Series and parallel circuits, currents add where branches meet and current as flow of charge | *As previous levels, plus:* |
| | Disciplinary Knowledge | | Use SI units. Make and record observations | Ask questions based on observations and prior knowledge | Make predictions using scientific knowledge |
| Magnetism & electromagnets | Substantive Knowledge | Magnetic poles, attraction and repulsion | *As previous levels, plus:*<br><br>Magnetic fields - plotting with compass, representation by field lines | *As previous levels, plus:*<br><br>Earth's magnetism, compass and navigation<br><br>The magnetic effect of a current | *As previous levels, plus:*<br><br>Electromagnets, D.C. motors (principles only).<br><br>Other effects of magnetic fields – Aurora borealis |
| | Disciplinary Knowledge | Understand that scientific theories develop as earlier explanations are modified to take account of new evidence and ideas | | Ask questions based on observations and prior knowledge | Make predictions using scientific knowledge |

| Energy | | Entering → | Emerging → | Developing → | Securing |
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| Energy Costs | Substantive Knowledge | | *As previous levels, plus:*<br><br>Fuels and energy resources | *As previous levels, plus:*<br><br>Domestic fuel bills, fuel use and costs | *As previous levels, plus:*<br><br>Comparing amounts of energy transferred (J, kJ, kW hour) |
| | Disciplinary Knowledge | | Ask questions based on observations and prior knowledge | | Use SI units. Apply mathematical concepts and calculate results |
| Energy Transfer | Substantive Knowledge | Comparing energy values of different foods (from labels) (kJ) | *As previous levels, plus:*<br><br>Comparing power ratings of appliances in watts (W, kW)<br><br>Energy as a quantity that can be quantified and calculated; the total energy has the same value before and after a change | *As previous levels, plus:*<br><br>Other processes that involve energy transfer: changing motion, dropping an object, completing an electrical circuit, stretching a spring, metabolism of food, burning fuels | *As previous levels, plus:*<br><br>Simple machines give bigger force at the expense of smaller movement (vice versa): product of force and displacement unchanged |
| | Disciplinary Knowledge | Use SI units. Present data using tables and graphs | Apply mathematical concepts and calculate results | Ask questions based on observations of the real world, using prior knowledge | Make predictions using scientific knowledge |

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| Work | Substantive Knowledge | | | | Work done as energy transferred (J) |
| | Disciplinary Knowledge | | | | Use SI units. Apply mathematical concepts and calculate results |
| Heating and Cooling | Substantive Knowledge | | Temperature difference between two objects leading to energy transfer from the hotter to the cooler one | *As previous levels, plus:*<br><br>Heating and thermal equilibrium: through contact (conduction) or radiation; such transfers tending to reduce the temperature difference: use of insulators | *As previous levels, plus:*<br><br>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 |
| | Disciplinary Knowledge | | Apply mathematical concepts and calculate results | Ask questions based on observations of the world, using prior knowledge | Make predictions using scientific knowledge |

| **Waves** | | **Entering** → | **Emerging** → | **Developing** → | **Securing** |
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| Sound | Substantive Knowledge | Sound produced by vibrations of objects | *As previous levels, plus:*<br><br>Sound needs a medium to travel, the speed of sound in air, in water, in solids | *As previous levels, plus:*<br><br>Frequencies of sound waves, measured in hertz (Hz); echoes, reflection and absorption of sound | *As previous levels, plus:*<br><br>Auditory range of humans and animals |

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| | Disciplinary Knowledge | Ask questions based on observations and prior knowledge | Apply mathematical concepts. Use SI units. | Present data using tables and graphs | |
| Light | Substantive Knowledge | Light travels in straight lines – simple ray model to explain shadows | *As previous levels, plus:*<br><br>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<br><br>Similarities and differences between light waves and waves in matter | *As previous levels, plus:*<br><br>Light waves travel through a vacuum; speed of light<br><br>Light transferring energy from source to absorber leading to chemical and electrical effects; photo-sensitive material in the retina and in cameras | *As previous levels, plus:*<br><br>Transmission of light through materials: absorption, diffuse scattering and specular reflection at a surface<br><br>Colours and the different frequencies of light, white light and prisms (qualitative only); differential colour effects in absorption and diffuse reflection |
| | Disciplinary Knowledge | Ask questions based on observations and prior knowledge | Understand that scientific theories develop as earlier explanations are modified to take account of new evidence | | Make predictions using scientific knowledge |
| Wave Effects | Substantive Knowledge | | | Waves can be reflected, and add or cancel – superposition | *As previous levels, plus:*<br><br>Pressure waves transferring energy; use for cleaning and physiotherapy by ultra-sound; waves transferring information for conversion to electrical signals by microphone |

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| | Disciplinary Knowledge | | | Ask questions based on observations and prior knowledge | Make predictions using scientific knowledge |
| Wave properties | Substantive Knowledge | | Waves on water as energy transfer through undulations | *As previous levels, plus:*<br><br>Difference between transverse & longitudinal waves | *As previous levels, plus:*<br><br>Waves travel through water with transverse motion |
| | Disciplinary Knowledge | | Understand that scientific theories develop as earlier explanations are modified to take account of new evidence. Ask questions based on observations and prior knowledge | | |

| **Organisms** | | **Entering** → | **Emerging** → | **Developing** → | **Securing** |
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| Movement | Substantive Knowledge | Structure and functions of the human skeleton, to include support, protection, movement… | *As previous levels, plus:*<br><br>…and making blood cells | *As previous levels, plus:*<br><br>The function of muscles and examples of antagonistic muscles | *As previous levels, plus:*<br><br>Biomechanics – the interaction between skeleton and muscles, including the measurement of force exerted by different muscles |

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| | Disciplinary Knowledge | Ask questions based on observations and prior knowledge | | | Apply mathematical concepts. Use SI units. |
| Cells | Substantive Knowledge | Cells as the fundamental unit of living organisms | *As previous levels, plus:*<br><br>How to observe, interpret and record cell structure using a light microscope<br><br>The functions of the cell wall, cell membrane, cytoplasm, nucleus, vacuole, mitochondria and chloroplasts<br><br>Similarities and differences between plant and animal cells | *As previous levels, plus:*<br><br>The role of diffusion in the movement of materials in and between cells | *As previous levels, plus:*<br><br>The hierarchical organisation of multicellular organisms: from cells to tissues to organs to systems to organisms.<br><br>The structural adaptations of some unicellular organisms |
| | Disciplinary Knowledge | Ask questions based on observations and prior knowledge | | | Present data using tables |
| Breathing | Substantive Knowledge | Why we breathe in terms of supplying oxygen to stay alive, and the role of the lungs in simple terms | *As previous levels, plus:*<br><br>The structure and functions of the gas exchange system in humans, including adaptations to function | *As previous levels, plus:*<br><br>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<br><br>The impact of exercise, asthma and smoking on | *As previous levels, plus:*<br><br>The role of leaf stomata in gas exchange in plants |

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| | | | | the human gas exchange system | |
| | Disciplinary Knowledge | Ask questions based on observations and prior knowledge | | Present data using tables and graphs | Ask questions based on prior knowledge |
| Digestion | Substantive Knowledge | Content of a healthy human diet: carbohydrates, lipids (fats and oils), proteins, vitamins, minerals, dietary fibre and water… | *As previous levels, plus:*<br><br>… and why each nutrient is needed<br><br>Calculations of energy requirements in a healthy daily diet<br><br>Consequences of imbalances in the diet, including obesity, starvation and deficiency diseases | *As previous levels, plus:*<br><br>the tissues and organs of the human digestive system, including adaptations to function…<br><br>The effects of recreational drugs (including substance misuse) on behaviour, health and life processes | *As previous levels, plus:*<br><br>… and how the digestive system digests food (enzymes simply as biological catalysts)<br><br>The importance of bacteria in the human digestive system |
| | Disciplinary Knowledge | Present data using tables and graphs. Ask questions based on observations and prior knowledge | | | |

| **Ecosystem** | | **Entering** → | **Emerging** → | **Developing** → | **Securing** |
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| Interdependence | Substantive Knowledge | | The interdependence of organisms in an ecosystem, including food webs and insect pollinated crops | *As previous levels, plus:*<br><br>The importance of plant reproduction through insect pollination in human food security | *As previous levels, plus:*<br><br>How organisms affect, and are affected by, their environment, including the accumulation of toxic materials |

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| | Disciplinary Knowledge | | Present data using tables and graphs. Ask questions based on observations and prior knowledge. Interpret data, including patterns, to draw conclusions | | |
| Plant reproduction | Substantive Knowledge | Reproduction in plants, including flower structure | *As previous levels, plus:*<br>Wind and insect pollination, fertilisation, seed and fruit formation | *As previous levels, plus:*<br>Seed dispersal methods | *As previous levels, plus:*<br>Quantitative investigation of seed dispersal methods |
| | Disciplinary Knowledge | Ask questions based on observations and prior knowledge | | | Apply mathematical concepts and calculate results. Present data using tables and graphs. Interpret data to draw conclusions |
| Respiration | Substantive Knowledge | All living organisms on Earth need energy to survive, and this energy is released inside cells | *As previous levels, plus:*<br>Respiration occurs in living organisms, including the breakdown of glucose to release energy for other chemical processes necessary for life | *As previous levels, plus:*<br>A word summary for aerobic respiration<br>How anaerobic respiration is different, and why it is sometimes necessary | *As previous levels, plus:*<br>The process of anaerobic respiration in humans and micro-organisms, including fermentation, and a word summary for anaerobic respiration |
| | Disciplinary Knowledge | 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 | | | |
| Photosynthesis | Substantive Knowledge | Plants make their own food, using energy from the sun | *As previous levels, plus:*<br>Plants make carbohydrates in their leaves by photosynthesis and gain mineral nutrients and water from the soil via their roots | *As previous levels, plus:*<br>The reactants in, and products of, photosynthesis, and a word summary for photosynthesis | *As previous levels, plus:*<br>The dependence of almost all life on Earth on the ability of photosynthetic organisms, such as plants and algae, to use sunlight in |

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| | | | | The adaptations of leaves for photosynthesis | photosynthesis to build organic molecules that are an essential energy store and to maintain levels of oxygen and carbon dioxide in the atmosphere |
| | Disciplinary Knowledge | 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 | | | |

| **Genes** | | **Entering** → | **Emerging** → | **Developing** → | **Securing** |
|---|---|---|---|---|---|
| Human reproduction | Substantive Knowledge | Reproduction in humans (as an example of a mammal), including the structure and function of the male and female reproductive system | *As previous levels, plus:*<br>The role of gametes in fertilisation | *As previous levels, plus:*<br>Gestation and birth, to include the effect of maternal lifestyle on the foetus through the placenta | *As previous levels, plus:*<br>The menstrual cycle (without details of hormones) |
| | Disciplinary Knowledge | 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 | | | |
| Inheritance | Substantive Knowledge | That we inherit characteristics from parents through sperm and egg cells | *As previous levels, plus:*<br>Heredity as the process by which genetic information is transmitted from one generation to the next via gametes | *As previous levels, plus:*<br>A simple model of chromosomes, genes and DNA | *As previous levels, plus:*<br>The part played by Watson, Crick, Wilkins and Franklin in the development of the DNA model |

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| | | | | | Genetic disorders may be inherited – Cystic Fibrosis |
| | Disciplinary Knowledge | Ask questions based on observations | 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 | | |
| Variation and Evolution | Substantive Knowledge | That all organisms show variation - well-known examples<br><br>That organisms complete for food, space, resources and mates | *As previous levels, plus:*<br><br>The variation between individuals within a species being continuous or discontinuous, to include measurement and graphical representation of variation | *As previous levels, plus:*<br><br>Differences between species, and the significance of producing viable offspring<br><br>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 | *As previous levels, plus:*<br><br>The variation between species and between individuals of the same species means some organisms compete more successfully, which can drive natural selection<br><br>The importance of maintaining biodiversity and the use of gene banks to preserve hereditary material |
| | Disciplinary Knowledge | Ask questions based on observations | 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 | | |

# The Science Curriculum Intent – KS4

## Key Stage 4

The key stage 4 curriculum continues to build upon the knowledge and skills that were delivered at key stage 3. Pupils are expected to continue to develop their knowledge of science and to continue to develop their skills in working scientifically. We offer GCSE qualifications in Combined Science Trilogy and Biology. Although we don't specifically offer Physics or Chemistry as separate GCSE qualifications we can support any pupils who wish to continue their studies in either of these subjects when they join us.

All pupils in Key Stage 4 access Science, and follow one of the pathways detailed below, leading to GCSE exam entry in Yr11. Pupils joining us during the Spring term of year 11 would still access GCSE Biology, but due to time constraints, this would be an abridged curriculum, addressing Core knowledge only – depending on their prior knowledge and school attendance.

## Key Stage 4 Combined Science Trilogy Pathway

The Key Stage 4 Combined Science Trilogy Pathway is a two year course and it is most suited to pupils who are expected to attend with us for at least 5 terms or more due to the large amount of content that pupils are expected to learn. It covers all three scientific disciplines of Biology, Chemistry and Physics and pupils who are entered for the qualification can achieve the equivalent of two GCSE qualifications. The curriculum is taken mapped out in a way in which knowledge builds upon prior knowledge from the key stage 3 curriculum and in a sequenced logical way. We begin with chemistry because this provides pupils with prerequisite knowledge of particles and how they interact, chemical reactions and the nature of matter, which underpin the physics and biology curricula.

| **Key Stage 4 Combined Science Trilogy Pathway** | **Autumn** → | | **Spring** → | | **Summer** → | |
|---|---|---|---|---|---|---|
| Year 10 | **Half Term 1** | **Half Term 2** | **Half Term 1** | **Half Term 2** | **Half Term 1** | **Half Term 2** |
| | **Chemistry**<br>• Atomic structure and the periodic table<br>• Bonding, structure and properties of matter | • Quantitate chemistry<br>• Chemical changes<br>• Energy changes | **Physics**<br>• Energy<br>• Electricity | • Particle model of matter<br>• Atomic Structure | **Biology**<br>• Cell Biology<br>• Organisation<br>• Infection and Response<br>• Bioenergetics | • Homeostasis<br>• Inheritance, variation and evolution<br>• Ecology |

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| Year 11 | • The rate and extent of chemical change<br>• Organic chemistry<br>• Chemical analysis | • Chemistry of the atmosphere<br>• Using resources | • Forces<br>• Waves<br>• Magnetism and electromagnetism | REVISON & EXAMS |

## Key Stage 4 Biology Pathway

The Key Stage 4 Biology Pathway is a two year course and it is most suited to pupils who are expected to attend with us for at least 4 terms or more due to the large amount of content that pupils are expected to learn. It covers in depth, the discipline of Biology, where pupils learn about the organisation of living things, the chemical reactions essential for life, diseases, genetics and how characteristics are inherited, evolution and the interdependence of organisms in ecosystems.

| **Key Stage 4 Biology Pathway** | **Autumn** → | | **Spring** → | | **Summer** → | |
|---|---|---|---|---|---|---|
| Year 10 | **Half Term 1** | **Half Term 2** | **Half Term 1** | **Half Term 2** | **Half Term 1** | **Half Term 2** |
| | • Cell Biology | • Organisation | • Infection and response | • Bioenergetics | • Homeostasis and response | • Inheritance, variation and evolution |
| Year 11 | • Ecology<br>*Infection and response*<br>*Bioenergetics* | • Key ideas<br>*Homeostasis and response* | • Revision<br>*Inheritance, variation and evolution*<br>*Ecology* | • Revision<br>*Revision* | *Exams* | |

# Assessment and Progress in Science

The Trust has established its own grade descriptors for Science in all of its secondary provisions, they range from Pre GCSE levels 1 to grade 9. The grade descriptors are aligned with GCSE grades, Functional Skills levels and Pearson Steps and they are called 'BIT Levels'. Progress is reported in these levels each term and teachers are expected to make a 'best fit' decision on which level each pupil is at for using a mixture of formative and summative assessments throughout each term. These levels are moderated both by the Science subject leads, SLT and the Trust's Central Team.

## BIT Level Descriptors for Science

| BIT Level | Descriptor |
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| 9 | To achieve grade 9, students' evidence will show that they have securely met<br><br>all the statements within the grade 8 descriptor, with stronger performance in most or all aspects of the grade 8 statements. |
| 8 | To achieve grade 8, candidates will be able to:<br><br>• demonstrate relevant and comprehensive knowledge and understanding and apply these correctly to both familiar and unfamiliar contexts using accurate scientific terminology<br>• develop accurate, logical and detailed descriptions, explanations and arguments<br>• use a range of mathematical skills to perform complex, multi-step scientific calculations<br>• critically analyse qualitative and quantitative data and draw logical, well-evidenced conclusions<br>• critically evaluate and refine methodologies, and judge the validity of scientific conclusions |
| 7 | To achieve grade 7, students' evidence will show that they have securely met all the statements within the grade 6 descriptor, with stronger performance in most or all aspects of the grade 6 statements. However, their evidence does not meet the minimum requirements of most of the grade 8 statements. |
| 6 | To achieve grade 6, candidates will be able to:<br><br>• demonstrate accurate and relevant knowledge and understanding and apply these mostly correctly to both familiar and unfamiliar contexts using accurate scientific terminology<br>• develop accurate, logical and detailed descriptions and straightforward explanations<br>• use a range of mathematical skills to perform multi-step scientific calculations<br>• analyse qualitative and quantitative data and draw logical conclusions, supported by evidence |

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| | • evaluate methodologies to suggest improvements and developments to experimental methods, and comment on the accuracy and validity of scientific conclusions |
| 5 | To achieve grade 5, candidates will be able to:<br><br>• demonstrate mostly accurate and appropriate knowledge and understanding and apply these mostly correctly to familiar and unfamiliar contexts, using mostly accurate scientific terminology<br>• develop mostly accurate and logical descriptions, which includes some relevant detail and simple explanations<br>• use appropriate mathematical skills to perform multi-step calculations<br>• analyse qualitative and quantitative data and draw plausible<br><br>conclusions supported by some evidence<br><br>• evaluate methodologies to suggest improvements to experimental<br><br>methods, and comment on the accuracy of scientific conclusions |
| 4 | To achieve grade 4, candidates will be able to:<br><br>• demonstrate some accurate and appropriate knowledge and understanding and apply these to some familiar and unfamiliar contexts, using some accurate scientific terminology<br>• develop some logical descriptions, which includes some accurate and relevant detail<br>• use appropriate mathematical skills to perform calculations<br>• interpret qualitative and quantitative data and draw conclusions<br><br>supported by some evidence<br><br>• suggest improvements to experimental methods, and comment on the<br><br>accuracy of scientific conclusions |
| 3 | Characteristics that differentiate a grade 3 from a grade 4:<br><br>• correct answers more likely to address familiar contexts than unfamiliar contexts |

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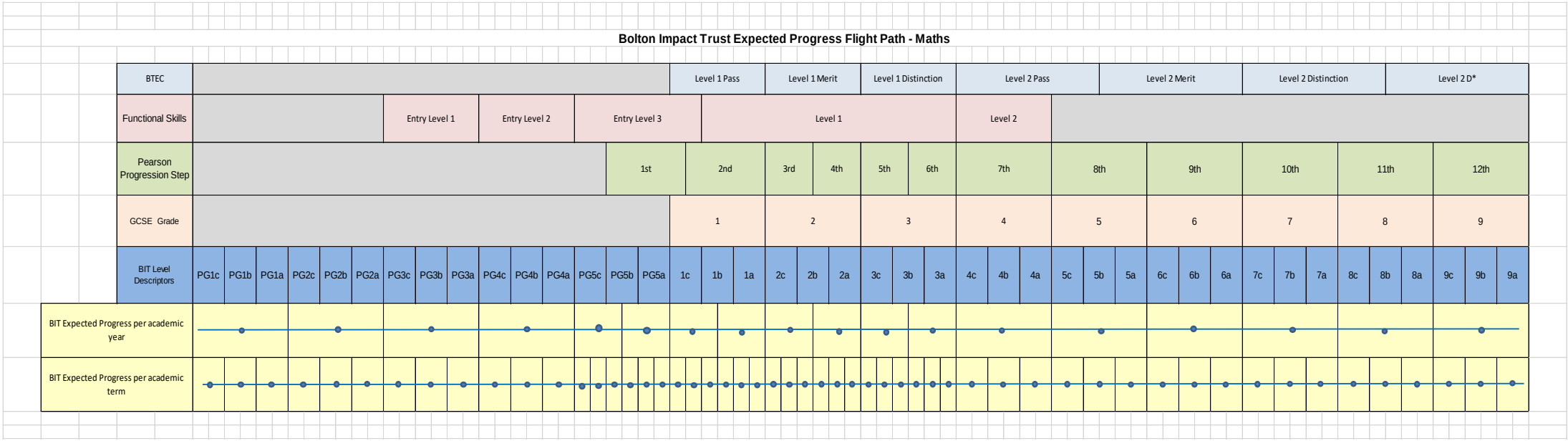
| | • correct answers more likely where prompts and scaffolding are provided<br>• descriptions are often partial and lacking relevant detail<br>• perform some calculations when scaffolding is given<br>• draw conclusions from qualitative or quantitative data, but evidence to<br><br>support may not be clear or present<br><br>• make some comments relating to experimental methods, but may not<br><br>demonstrate an understanding of how to improve the experimental method or the accuracy of scientific conclusions |
| 2 | To achieve grade 2, candidates will be able to:<br><br>demonstrate some relevant scientific knowledge and understanding using limited scientific terminology<br><br>• perform some basic calculations<br>• draw simple conclusions from qualitative or quantitative data<br>• make basic comments relating to experimental methods |
| 1 | To achieve a grade 1, students' evidence will show that they have demonstrated engagement with sufficient content, achieved some credit across elements of the specification content and achieved credit in some assessment objectives. |

# Science Flight Path

In Science we have high expectations for our pupils and we use the flight path created for Maths across the Trust to judge the progress of our pupils each term. Once a pupil has been baselined, teachers calculate their expected progress using the flight path and reports each term whether pupils are meeting their expected progress, exceeding, or have not met. Pupils who do not meet their expected target level in Science are offered additional support.



## SEND

In Science, pupils with additional SEND are identified on entry via our pupil referral system, with specific targeted support strategies identified and recorded on the pupil's Personalised Learning Plan. The majority of pupils will join either a KS3 or KS4 class with their peers, accessing the full complement of 5 science lessons per week. Careful consideration is given to seating arrangements and environmental considerations, such as lighting, sound levels and wall displays, according to the information provided at referral.

All science lessons are taught by an experienced science specialist teacher, with additional classroom support provided by a designated Learning Mentor, allocated to best support science learning. The Science teacher and designated Learning Mentor collaborate with curriculum implementation, and recommendations for individual pupils are discussed on a daily basis. Teaching and pastoral support strategies are reviewed daily, in order to respond quickly to pupils' additional needs in science.

Some pupils who join Park School may need additional pastoral support to meet their SEMH needs. These pupils join a smaller Well-being group, and access 2 science lessons per week, taught by the science specialist teacher. Pupils in the Well-being group access learning with further differentiation and use of therapeutic and kinaesthetic teaching activities in order to meet their specific additional needs. Pupils in the Well-being group have access to the full science curriculum, with their progress tracked and reviewed in line with their peers in the other groups. The aim here is to provide those pupils who require higher level of pastoral care, additional time to integrate fully into school. Pupils are then supported by a phased transition into the relevant core group, in order to access the full allocation of science lessons.