Science

Curriculum Overview Science

Key Stage – KS4 Year - 9

Location of resources:	**Science Subject Staff – KS4**
Curriculum intent and rationale:	At John Port Spencer we believe in developing a passion for Science. We set high expectations of students to ensure that they can excel in Biology, Chemistry and Physics. In doing so our students are ambitious of what they can achieve. We have an inclusive curriculum in which all students of all abilities have an opportunity to progress at all levels. Our curriculum is designed so that: - Students develop their knowledge and understanding of scientific concepts, building on previous knowledge, so that their understanding deepens over time - Students develop working scientifically skills to that they can predict, plan, carry out, analyse and evaluate their practical scientific investigations - Students are curious about the world around them and are encouraged to ask questions to develop more depth in their understanding. - Students can communicate their ideas, explaining them using the correct scientific language - Student's ideas are challenged so that misconceptions are identified and addressed. - Students are inspired to consider a science related career.
National Curriculum Links:	**Biology** • Cells as the basic structural unit of all organisms; adaptations of cells related to their functions; the main sub-cellular structures of eukaryotic and prokaryotic cells. Stem cells in animals and meristems in plants. • The need for transport systems in multicellular organisms, including plants. The relationship between the structure and functions of the human circulatory system. **Chemistry** • A simple model of the atom consisting of the nucleus and electrons, relative atomic mass, electronic charge and isotopes. The number of particles in a given mass of a substance. The modern Periodic Table, showing elements arranged in order of atomic number. • Position of elements in the Periodic Table in relation to their atomic structure and arrangement of outer electrons. Properties and trends in properties of elements in the same group characteristic properties of metals and non-metals. Chemical reactivity of elements in relation to their position in the Periodic Table. • Changes of state of matter in terms of particle kinetics, energy transfers and the relative strength of chemical bonds and intermolecular forces. Types of chemical bonding: ionic, covalent, and metallic. Bulk properties of materials related to bonding and intermolecular forces. Bonding of carbon leading to the vast array of natural and synthetic organic compounds that occur due to the ability of carbon to form families of similar compounds, chains and rings. Structures, bonding and properties of diamond, graphite, fullerenes and graphene. **Physics** • Energy changes in a system involving heating, doing work using forces, or doing work using an electric current: calculating the stored energies and energy changes involved. Power as the rate of transfer of energy. Conservation of energy in a closed system, dissipation. Calculating energy efficiency for any energy transfers. Renewable and non-renewable energy sources used on Earth, changes in how these are used. • Measuring resistance using potential difference and current measurements. Exploring current, resistance and voltage relationships for different circuit elements; including their graphical representations quantity of charge flowing as the product of current and time. Drawing circuit diagrams; exploring equivalent resistance for resistors in series • the domestic a.c. supply; live, neutral and earth mains wires, safety measures. Power transfer related to potential difference and current, or current and resistance.

Science

Curriculum Overview Science

Key Stage – KS4 Year - 9

What content needs to be covered? Key Knowledge and skills / misconceptions to address (with vocab in bold and spelling underlined)
By the end of the year students will know:

Half Term 1	Half Term 2	Half Term 3	Half Term 4	Half Term 5	Half Term 6
Students will learn key knowledge and skills about: • **Atomic structure and periodic table** • **Cells** **Required practical:** • **Using a microscope** **Throughout the unit's students develop their working scientifically skills** **Challenge:** Asking students to visualize and understand the abstract concepts of subatomic particles and their behaviour. Additionally, grasping the concepts of isotopes and ions. Balancing equations. Asking students to understand the abstract concept of a cell as a complex, three-dimensional structure with dynamic processes, rather than just a collection of static parts. Calculating cell size and the functions of large amount of different organelles. **Misconceptions:** The belief that electrons orbit the nucleus in fixed paths like planets around the sun, rather than existing in probability-based orbitals. Another misconception is that atoms are the smallest units of matter, ignoring the existence of subatomic particles like protons, neutrons, and electrons. Additionally, students sometimes mistakenly believe that atoms of different elements are identical, or that the number	**Students will learn key knowledge and skills about** • **Cells (continued)** • **Energy** **Required practical:** • **Specific heat capacity** **Throughout the unit's students develop their working scientifically skills** **Challenge:** Calculating energy, rearranging equations, converting units and using standard form provide students with challenge in this topic. **Misconceptions:** Students often struggle with the abstract nature of energy, confusing it with concepts like force, work, or power, or believing it can be created or destroyed. Specifically, they may think energy is a substance that is used up or produced during reactions, or that it exists in different forms rather than just being stored and transferred. **Subject specific terminology:** Kinetic, gravitational potential, joules, elastic potential, specific heat capacity	**Students will learn key knowledge and skills about** • **Bonding** **Throughout the unit's students develop their working scientifically skills** **Challenge:** Students are challenged in bonding by the abstract nature of the concepts and the need to visualize microscopic structures and then relate this to their relationship to macroscopic properties. . **Misconceptions:** The idea that ionic bonding involves sharing electrons (it's transfer), covalent bonding involves electron transfer (it's sharing), and that atoms bond solely to achieve a full outer shell. Additionally, some students believe that energy is released when bonds break, rather than when they form. **Subject specific terminology:** Ionic, covalent, metallic, electrostatic attraction, intermolecular bonds, fullerene, buckminsterfullerene	**Students will learn key knowledge and skills about** • **Transport across membranes** • **Circuit electricity** **Required practical:** • **Resistance of a wire** • **IV characteristics** **Throughout the unit's students develop their working scientifically skills** **Challenge:** Asking students to understand the differences between diffusion, osmosis, and active transport, as well as the factors affecting their efficiency. Additionally, grasping the role of proteins in membrane transport and the concept of concentration. Asking students to explain the flow of current, the roles of voltage and resistance, and how these concepts relate to each other in a circuit. Calculations, rearranging equations, converting units provide students with challenge in this unit. **Misconceptions:** A common misconception in teaching electricity at the GCSE level is that electricity is "used up" as it flows through a circuit. This leads to the idea that components later in the circuit receive less current than those earlier, which is not true in a series circuit. Another misconception is that electricity flows out of both ends of a battery or that a battery stores charge.	**Students will learn key knowledge and skills about** • **Transport in animals and plants** **Throughout the unit's students develop their working scientifically skills** **Challenge:** Asking students to explain the complexity of a three-dimensional system with abstract concepts like pressure, flow, and the interconnectedness of different components. Asking students to understand the functions of different vessels like arteries, veins, and capillaries. Asking students to explain the abstract nature of the processes involved and the need to integrate multiple concepts. Students often struggle to grasp the interconnectedness of transpiration, translocation, osmosis, and diffusion, as well as the structural adaptations of xylem and phloem. **Misconceptions:** The belief that blood is made in the heart, that the heart is the only site of oxygen and carbon dioxide exchange, that the left side of the heart contains deoxygenated blood, and that the right side of the heart pumps blood further than the left.	**Students will learn key knowledge and skills about:** • **Domestic electricity** **Throughout the unit's students develop their working scientifically skills** **Challenge:** Explaining the dangers of electric shock and burns, especially when dealing with mains voltage. **Misconceptions:** Students often believe mains electricity is a direct current (DC) supply, rather than an alternating current (AC) supply. Another misconception is that the live and neutral wires are interchangeable. **Subject specific terminology:** National grid, Power, live, neutral, earth, fuse, alternating current, direct current

of protons and electrons in an atom must be equal. Specifically, students often misinterpret the nucleus as the "brain of the cell" or believe that all cells have the same DNA and thus the same function. **Subject specific terminology:** Eukaryotic, prokaryotic, cytoplasm, chloroplast, cell membrane, cell wall, chlorophyll, mitochondria, ribosome, vacuole, microscope, coverslip, slide, iodine. Element, compound, electrons, neutrons, protons, shells, nucleus, ion, isotope, gold foil scattering experiment, alkali metals, halogens, noble gases, groups, periods, Bohr, Chadwick, plum pudding, nuclear model.			That diffusion stops when concentration is uniform across the solution. Similarly, when we present them with a beaker with a salt solution of a given concentration and ask whether there would be any diffusion, most say, “no”, since there is no concentration gradient. Students do not realize that the process is due to the dynamic and particulate nature of matter but instead remain stuck to the idea of concentration gradient. The other most common misconception in osmosis is that solvent is fluid and continuous while the solute is particulate. **Subject specific terminology:** Current, coulomb, charge, potential difference, ammeter, voltmeter, resistance, ohm, amps, volts, variable resistor, diode, parallel, series, cell, battery, resistor. Diffusion, osmosis, concentration, active transport, particles, concentration gradient.	Water enters plants only through their leaves, particularly when it rains. Students often struggle to grasp that water is absorbed by the roots and transported upwards through the xylem to other parts of the plant. Another area of confusion is the role of transpiration, with students sometimes thinking it's the only way water is used by plants. Additionally, students may mistakenly believe that plants "breathe" like animals or that glucose is transported in the phloem **Subject specific terminology:** Atria, ventricles, aorta, vena cava, pulmonary, coronary, stains, stent, pacemaker, coronary heart disease, valves, arteries, veins, capillaries. Xylem, phloem, transpiration, translocation, stomata, guard cells, lignin.	

Previous learning that is particularly relevant:

At KS3 students will have learnt the functions of some of the parts of the cell and the parts of the microscope. At KS3 students will have learnt the meaning of an element and compound, with atoms just being spheres. At KS3 students will have learnt some types of energy store and that energy is transferred. They would have learnt how to measure forces and the unit for force.	At KS3 students will have learnt that atoms can be joined together with a chemical bond. At KS3 students will have learnt that the cell membrane controls what enters and leaves the cell. At KS3 students will have learnt some circuit symbols, described what we mean by current and potential difference and how to measure these in a series and parallel circuit.	At KS3 students will have learnt where the heart is and that it is part of the circulatory system. They would have learn how water enters and travels through a plant. At KS3 students will have learnt the difference ways in which electricity can be made by difference energy resources such as solar and wind energy.

Future Learning - How content prepares students for future units, Key Stage 4, or Key Stage 5?

Knowledge on cells will prepare students for understanding how these cells link with the tissues of the plant. For example, learning about the palisade cell links with the work on photosynthesis later in the course. Knowledge on the structure of the atom is fundamental to understanding many of the following units in chemistry, including bonding, ions and electrolysis. A Level Biology then builds on this knowledge of cells by learning about more parts of the cells and their functions.	Knowledge of bonding prepares students for the later unit of organic chemistry in which they have to understand the structure of hydrocarbons. Knowledge of circuit electricity links prepares them for understanding domestic electricity which is taught in the following term. At A Level chemistry bonding in taught in much more detail in terms of the role of the electrons. At A Level physics there are further, more complex electricity calculations that builds on the knowledge of GCSE.	Knowledge of the transport in organisms prepares them for understanding how substances such as hormones and cells of the immune system (in later units) travel around the body. It supports their learning in understanding of the importance of oxygen in respiration and this links with the respiration unit in year 10. At A Level Biology this prepares them for understanding the cardiac cycle and interpreting heart rate graphs.

JOHN PORT SPENCER ACADEMY

Science

Curriculum Overview Science

Key Stage – KS4 Year - 9

Outcomes:
By the end of the year pupils will be able to solve/create/produce/write:

- Answer questions that demonstrate their knowledge and understanding of scientific ideas, including multiple choice, short answer and extended response. (AO1)
- Demonstrate the skills of working scientifically including drawing graphs, identifying variables and planning, concluding and evaluating investigations (AO1)
- Answer questions in which they can apply their knowledge to unfamiliar scenarios across topic areas (AO2)
- Answer questions in which they analyse ideas, evaluate, make judgements and draw conclusions. They should be able to make suggestions about how to improve am experimental procedure (AO3)

Assessment Strategy How we know our students are knowing and remembering more –
Data from hunting not fishing, formative and summative assessment/s is used to adapt teaching and provide targeted challenge and intervention, supporting SEND and disadvantaged pupils.

Formative:

White boards are 'on hand' in every lesson and are used routinely in every lesson to check understanding at each point of the learning journey of the lesson.

Teachers circulate to make sure that students understand what they are doing and assess the understanding, re teaching within the lesson where needed.

Exit tickets are used to check students understanding at the end of the lesson.

Summative (& cumulative)
Unit assessments in

- Cells
- Energy
- Atoms and periodic table
- Transport across membranes
- Circuit electricity
- Bonding
- Transport in plants and animals
- Domestic electricity

Opportunities to revisit past learning:

The starter questions are designed for students to recall from the current topic and past topics.

The development lesson after the assessment students revisit and relearn the sections of the topic that they don't understand.

There is a revision schedule built into the curriculum leading up to mock exams and examinations.

There are 'spaced' learning lessons where the teacher goes back to previous topics.

Opportunities for homework (including apps):
Students complete their Sparx homework which consolidates what they have done in lesson and questions on topics they struggle with.
The insights tool helps teachers focus on areas their classes are getting wrong.

For each topic students complete an exam question homework which is then self-assessed in class.

How is the curriculum adapted to meet the needs of SEND and disadvantaged pupils, while maintaining high expectations?

Many of the concepts in science involve abstract ideas. We use visuals and physical models the help students understand fundamental theories like the particle model – a threshold concept which allows them to understand further phenomena. We also use dual coding to help students visualise what it looks like and help them retain this into their long-term memory.

There is lots of subject specific vocabulary which is pre taught at the beginning of the lesson. A focus of repeating these key words and returning to them is used to help students retain these in their long-term memory.

We use scaffolding techniques to help SEN students make progress. This may be sentence starters, key words to use in order in individual support in starting the task.

These are main strategies we use in Science with our disadvantaged students

- They experience success in every lesson, increasing confidence and a belief in themselves
- Demonstrating excellence to them so that they understand what they are aiming for to increase the expectation of what they can achieve
- Support with resources at home. Many of our disadvantaged students have lower attendance, sometimes through no fault of their own. Having a workbook and revision guides, knowing what sections to complete if they are away helps support their learning and means that they can understand the lesson when they return.
- Priority seating and first for feedback in live marking.

Curriculum Overview Science
Key Stage – KS4 Year - 9

Wider Curriculum and Enrichment – cultural capital and real world application -

Enriching experiences:

Science support on specific topics are offered after school.

Our curriculum supports the school value of:

Joy	*Foster enthusiasm and engagement by* Engaging experiments, allowing students to actively participate and use these to understand concepts. Opportunities to take science outside, particularly with the Ecology unit. Model building and hands on activities to help with abstract concepts. Games and quizzes to make the learning interactive. A wide range of variety so lessons, although the same format, lessons are not all the same. Working in pairs and groups on activities to engage students with their peers.
Progress	*We monitor and support progress through* Every lesson teachers monitoring the progress of the students (see formative assessment). The results from each topic tests are monitored to ensure students are making progress towards their target grade.
Success	*We celebrate success* by Praise used with students in lessons in the moment. Use of other students work on the visualizer to celebrate a student's success publically. Following a unit test result students can receive a 'personal best' certificate or 'top f the class' certificate. At the end of each half term students are nominated for being a science superstar and these are given out with small prizes. Excellent student work in displayed in the faculty.
Act with care, kindness, respect, and integrity	*We build meaningful connections with our students by* *Giving students the opportunity to work in groups in which they are expected to respect each other to be an effective team. Encouraging students to speak to be kind to each other. Students work with integrity during practical work, following instructions, being safe and recording results accurately.*

Literacy, Oracy and disciplinary language:

Reading:

Students read and comprehend scientific texts, to grasp concepts and information.

Writing

Writing practical methods and conclusions, extended response in which they have to sequence a series of ideas in a logical sequence. Explain, and summaries, in which students to articulate their understanding clearly and accurately using the correct scientific terminology.

Listening

Students take part in active listening as this is essential for understanding scientific concepts presented by teachers and peers, and for engaging in meaningful discussions.

Speaking

Students say the subject specific vocabulary so that they can explain scientific ideas accurately and are more likely to use these words in their written work.

The teaching of science to Year 10 develops a range of these literacy skills which include

- Writing out a step by step written method
- Completing extended response questions
- Reading out loud from textbooks and articles
- Watching a video and answering questions while they do this
- Comprehension exercises
- Matching words to their definitions
- Looking up the meaning of words in a glossary
- Selecting the correct word to use from a list of choices

Cross-Curricular opportunities / Opportunities to develop 'character':

History: How scientists collected evidence and developed theories e.g. Theory of natural selection Darwin, Lamarck, Mendel, Newton.

Maths: Athematic and number, handling data, algebra, graphs, geometry and trigonometry.

Geography: Impact of climate change, ecosystems, adaptations to the environment.

English: Constructing an evaluation with different viewpoints. Expressing and explaining ideas and theories using written communication.

PRE: Ethical viewpoints that scientist have to consider e.g. using embryos for research.

Our curriculum supports personal development by:

Discussion of different viewpoints and empathy for those making these choices e.g. the choice to have embryo screening for genetic diseases.
The ability to understand and evaluate what they read in the news that links to what they are learning e.g. Climate change. They may then use this information to make their own life choices in the future.
An understand of 'fake news' which may not be from a reliable source.

Careers / Employability skills:
How does the curriculum link to the following employability skills:

Listening – Active listening, which involves focused attention and understanding of what others are saying. It's essential for effective communication, collaboration, and problem-solving. Active listening demonstrates respect, builds rapport, and helps individuals grasp information accurately and efficiently.

Speaking – Speaking skills are crucial for science professionals as they enable effective communication of complex information, collaboration in teams, and successful presentation of research findings. These skills are essential for securing and excelling in scientific careers, encompassing clear and concise communication.

Problem solving – Problem-solving is a crucial employability skill, particularly in science fields, as it involves identifying and analysing problems, developing solutions, and evaluating their effectiveness. Scientific problem-solving relies on critical thinking, creativity, and a systematic approach to finding solutions. Employers highly value candidates who demonstrate strong problem-solving abilities, as these skills are transferable to various work situations and contribute to career success.

Curriculum Overview Science

Key Stage – KS4 Year - 9

Aiming high – Setting ambitious goals, developing relevant skills, and actively seeking opportunities for growth and advancement. It involves proactive planning, a positive attitude towards challenges, and the ability to learn from setbacks. This approach is crucial for success in scientific careers, as it enables individuals to tackle complex problems, collaborate effectively, and contribute to innovation.

Critical thinking – Critical thinking is a crucial employability skill, particularly valuable in science-related fields. It involves actively analysing information, evaluating evidence, and solving problems using reasoned judgment. For science graduates, critical thinking is essential for data analysis, research design, and navigating complex scientific concepts

Staying positive – Staying positive and developing a growth mindset are crucial for success in science-related careers. A positive attitude, resilience, and adaptability are valuable employability skills that can be cultivated through self-reflection, practice, and seeking support. These qualities enhance problem-solving, foster innovation,

Leadership – Leadership skills, in particular, demonstrate an individual's ability to motivate, manage, and influence others, making them valuable assets to any organization

Teamwork – Teamwork is a crucial employability skill involving working effectively with others to achieve a shared goal. It encompasses various sub-skills like communication, problem-solving, active listening, and conflict resolution. Developing these skills enhances collaboration, efficiency, and overall productivity

Creativity – Creativity is a highly valued employability skill across all fields, including science and technology. It enables individuals to approach problems with innovative solutions, adapt to change, and contribute to advancements.

Employment Sectors discussed include:

Botanist
Electrician
Electricity generator workers
Cardiologist

Science

Curriculum Overview Science

Key Stage – KS4 Year - 9

Curriculum impact is evaluated through pupil study, work scrutiny, and progress data. Findings inform regular curriculum review to ensure continuous improvement.

When was this curriculum last reviewed? Include date	What changes were made and why?	How is ongoing improvement ensured?
22nd July 2025	Movement of bonding into year 9 so that more lesson time can be dedicated to students learning. More spaced learning in year 9 so that threshold concepts are secure before going into year 10.	Review of student progress on each unit to ensure that the correct amount of time and sequencing builds on previous learning.