EDClass Science - Physics Rationale

Why is the study of physics important?

One of the three sciences that learners have the opportunity to study during Key Stage 3 (KS3) and Key Stage 4 (KS4) is physics. It provides the foundations for comprehending the world around us and builds understanding in a wide range of ideas, from the development of the universe to explaining the motion and behaviours of matter and new emerging technology.

Within physics, learners explore concepts including energy resources and energy conservation. Fossil fuels and global warming are critical problems in the world today, and physicists are working towards finding alternative energy resources and reducing energy usage. Through the study of these topics, learners gain an understanding and develop a scientific viewpoint of the world. This empowers learners to make informed decisions about energy and environmental issues, which is essential for responsible citizenship.

Physics has many practical applications that majorly impact daily life. The study of physics aims to help learners understand some of these real-world uses. In modern society, electrical power is essential for artificial lighting, sound and entertainment. In physics lessons, learners explore how electric charge is a fundamental property of matter. They also begin to appreciate conductors, insulators, design of components and how electrical circuits are powered. Additionally, learners will learn how electricity is generated and its costs. Understanding these concepts is important in a world with an increasing demand for electricity. Physics also has further applications in medical sciences. Our learners will study about the use of X-rays and ultrasound in medical imaging, as well as radiation therapy in cancer treatment.

Studying physics not only builds subject specific knowledge, but also develops a variety of skills that are used across many subjects in the curriculum. Some of these skills include numeracy, literacy and following the scientific method. Learners also practice logical and mathematical reasoning to solve problems. By building learners' confidence in these transferable skills, studying physics can inspire new possibilities and facilitate future opportunities.

Why study physics in this order?

The physics curriculum is sequenced to allow learners to build a foundation of knowledge as they progress from one key stage to the next. By following the national curriculum, learners are taught components of knowledge before advancing to subsequent lessons. This sequence ensures an appropriate level of challenge for our learners and supports good progress.

The spiral nature of the content within physics means that learners in KS4 revisit topics they have encountered previously. Revisiting fundamental concepts not only secures knowledge, but deepens learners' understanding through covering content in more detail with higher demand skills. For instance, in Key Stage 2 (KS2) learners acquire basic knowledge about light and sound. In KS3, this knowledge is expanded on within the waves topic. Finally, in KS4, learners deepen their knowledge and skills by exploring wave calculations, practical examples and applications of electromagnetic waves. This sequence allows learners to re-engage with prior knowledge, and it helps make links to previous learning explicit.

Additionally, through the use of assessment, the physics curriculum considers learners' existing knowledge and skills. Using assessment allows pathways of learning to be tailored to individual learners, ensuring the cohesion of knowledge and supporting progression.

What previous learning is needed?

Before beginning the KS3 physics curriculum, learners should have a foundation of basic knowledge from the sciences in key stages 1 and 2. The key topics are listed in the national curriculum and include: light, sound, forces and magnets, states of matter, electricity and earth and space.

Additionally, learners starting the physics curriculum should have developed skills in working and thinking scientifically. This could include planning scientific enquiries to answer questions, recognising and controlling variables, taking measurements using scientific equipment, recording data, reporting and presenting findings, and writing conclusions and explanations. Throughout the curriculum, assessment opportunities identify specific areas or skills that learners may need to revisit in order consolidate prior learning before progressing further.

What are the links to literacy?

The physics curriculum offers many opportunities to develop learners' literacy skills. Throughout the curriculum lessons in physics will outline key terminology to learners, providing the correct spellings and subject specific definitions. Furthermore, these words will then be placed in context to model how they should be used, supporting learners to develop their vocabulary and language.

Developing reading and listening skills is essential for learners in physics. As learners engage with lessons, they read text and listen to explanations in order to retrieve knowledge and extract necessary information for various tasks. Additionally, learners develop their comprehension skills by understanding, interpreting and making connections between subject content and questions posed. To support learners with this, command words commonly found in exam questions are explained. For example: describe, which involves recalling facts or processes; explain, requiring a scientific reason; and evaluate, where learners discuss the advantages and disadvantages of a given topic. Through the understanding of command words, learners can more effectively demonstrate their understanding in science questions

Furthermore, to support learners with writing, physics lessons include practice questions accompanied by model answers. These exemplify how to structure, organise and connect ideas while writing. The examples may involve using key terminology in short answer questions or demonstrate how to approach extended response questions. Developing these skills are essential as they support learners in understanding the requirements when writing and in developing their responses.

What are the links to numeracy?

There are many links between numeracy and physics, making it essential to include these skills in the curriculum. Learners are required to perform simple calculations, such as calculating the surface areas and volumes of shapes. Additionally, they are required to recall equations, manipulate the subject and substitute numerical values into algebraic equations. A few examples include the equations for calculating kinetic energy, specific heat capacity and potential difference. Furthermore, learners should be proficient in decimal form, standard form and the use of significant figures, ratios, fractions and percentages in their answers.

Handling data is an essential skill within the physics curriculum. Learners use data during exam practice questions and when working with data collected from required practicals. They should apply their knowledge to calculate the mean, median and mode, or perform order of magnitude calculations on the collected data. Additionally, to demonstrate their ability to record and present data, learners construct tables and charts and plot variables from experimental data. Examples of practicals where these skills are require, include investigations into the effectiveness of different materials as thermal insulators, or studying how the length of a wire at constant temperature affects the resistance of electrical circuits.

Interpreting data is an essential numeracy skill that learners have the opportunity to learn and practice within physics. They describe, explain, evaluate and draw conclusions from data presented in various forms. Specifically, learners should understand how linear relationships are represented on graphs, determine the slope and intercept and recognise the significance or the area under a curve. Additionally, they should also know how to draw and use the tangent of a curve to calculate the rate of change.

In addition to the skills mentioned above, learners must also demonstrate understanding by effectively using mathematical language in their explanations. All these numeracy skills are taught and modelled within the physics curriculum, and further questioning provides opportunities to practice specific requirements at the appropriate level of demand or key stage.

How is SMSC embedded?

Spiritual, Moral, Social and Cultural (SMSC) links are outlined in the physics curriculum. By providing opportunities to develop these skills, learners are encouraged to consider how their learning relates to the world around them and appreciate their role in society.

Within physics, learners are inspired to reflect on deeper questions related to the universe and fundamental laws of physics. This supports their spiritual development. For example, when learning about a theory explaining the creation of the universe, learners form their own opinions based on the evidence presented.

Studying physics encourages critical thinking and evidence evaluation, which is valuable for learners' moral development. By reflecting on the consequences of scientific discoveries, such as radiation and nuclear power hazards, learners develop a sense of responsibility and moral awareness. Learners will therefore also consider the ethical responsibility of scientists. Additionally, they form opinions on topics such as energy resources, looking at different methods for generating energy and considering the implications of using finite resources and their impact on the landscape.

In the physics curriculum, discussing the contributions from various scientists in the development of the atomic model, exemplifies the importance of collaboration, and contributes to social development. Additionally, studying physics enhances scientific literacy, empowering learners to participate in real-word debates or understand scientific advancements. This could be related to the energy crisis, the environment or health, for example radiation therapy.

Cultural development focuses on learners gaining respect for different beliefs, values and cultural perspectives. In physics, this is instilled when learners are taught about theories explaining the creation of the universe as there is the consideration of religious beliefs.

How are British Values embedded?

British Values are referenced throughout the physics curriculum. The British Value of democracy is embedded within physics lessons where learners consider the scientific method. Within these lessons, learners are taught about formulating and testing hypotheses, and analysing data to form collective knowledge that is evidence based. Furthermore, collaboration within the science community is exemplified when learning how the model of the atom developed. As learners also engage with topics that affect the real world, they could consider how their knowledge of physics influences policy and incentives, such as solar energy, wind power or home insulation. Similarly to other practical subjects, in physics, learners appreciate the rule of law when following learning how to keep themselves and others safe in a practical setting. Individual liberty is promoted in the physics curriculum, when learners express their views during 'discuss' and 'evaluate' exam practice questions. Respecting diverse viewpoints contributes to the value of mutual respect and tolerance. Learners appreciate different cultural, religious and scientific perspectives, within lessons including the solar system, origins of the universe and red shift.

How are equal opportunities embedded?

One way the physics curriculum considers equal opportunities is by using varied teaching materials. Lessons incorporate text, diagrams, videos and a range of questions. These questions assess the knowledge of the learner and helps to check their understanding. Learners receive subject-specific support, allowing language and questions to be targeted appropriately to, considering the needs of the individual learner. Additionally, this encourages active participation, where learners can ask questions during their lessons. The content is made more accessible by including key vocabulary definitions, scaffolding and model answers to support learners. These strategies aim to help learners to make good progress in physics.

How are links made to the Wider World / Cultural Capital / Experiences / Cross-Curricular?

Within physics, learners study fundamental concepts to help them understand the universe and natural world. There are, therefore, many links to the wider world within physics. When studying forces, learners are taught how to calculate speed and how to keep safe on roads, taking into account stopping distance. Within the topic of energy, learners appreciate how electricity is generated, using different energy resources, and how this energy is then supplied to consumers through the national grid. This knowledge enables learners to appreciate where the electricity they use each day comes from. Linking to skills they need in the wider world, learners also calculate the cost of electricity, compare power ratings and energy values, and consider the benefits and costs of insulation in a house. Learners discover real-life applications of scientific concepts when they learn about loudspeakers, headphones and microphones in the topic of electromagnetism.

Cultural capital within physics encompasses the development of knowledge and skills that learners can apply to succeed further in life. In their physics education, learners acquire a range of skills, including numeracy, literacy, problem solving, data handling and interpretation, as well as a variety of practical skills involving the use of apparatus and measuring quantities. Learners also gain knowledge about how physics impacts the world they live in. They learn about the applications of electromagnetic waves, understanding how technologies like X-rays and gamma rays impact our health through medical imaging and treatments. Another example is within the energy topic, where learners discuss the advantages and disadvantages of various energy resources. This understanding helps them recognise the impact of their future choices and consider factors such as energy suppliers, political policy and preservation of the environment. Furthermore, learners are taught about trends in energy resource use, and gain an appreciation of others in the world around them.

There are many cross-curricular links to other subjects within physics. Mathematics has clear connections, with numeracy skills being a significant focus in the curriculum. For example, learners need to perform calculations, consider units of measurement and rearrange equations. Within the other sciences, chemistry shares content with the physics curriculum including states of matter and the atomic model. While biology links to the waves topic in physics. Colours of light and their absorption are important in photosynthesis and both can explain how the eye functions and how we hear sounds through the ear. Sound waves also appear in the subject of music, as learners explore how vibrations create sound. In the context of geography, energy resources are discussed, if they are renewable or non-renewable and their impacts. Furthermore, physics also helps explain movements of the Earth's crust when learning about convections currents. Lastly, historical links are apparent when learners are taught about the development of the model of the atom.

What key knowledge will be covered?

Within KS3 physics, the following topics are covered:

- Forces and Motion,
- Energy,
- Waves,
- Electricity and Magnetism,
- Matter,
- Space Physics

Within KS4 physics, the following topics are covered:

- Energy,
- Electricity,
- Particle Model of Matter,
- Atomic Structure,
- Forces,
- Waves,
- Electromagnetism,
- Space.

What key skills will be covered?

- Literacy skills, including, understanding command words, using scientific vocabulary and structuring responses, including evaluating given information.
- Numeracy skills, including, performing calculations, applying formulas, using SI units, presenting observations and other data as tables, graphs or drawings, interpreting and analysing various forms of data.
- Investigative skills, using scientific theories and explanations to develop hypotheses, identifying and controlling variables and planning experiments to test these hypotheses and make observations.
- Practical skills, using specialist equipment to take measurements, recognising hazards and planning how to minimise risk and recording a range of observations and measurements accurately.
- Critical analysis skills, evaluating the method and suggesting possible improvements and further investigations as well as drawing conclusions.

Are there interleaving opportunities?

The physics curriculum aims to incorporate interleaving opportunities to enhance learning. One approach is through assessments. These assessments can include interleaved questions from recent and previous topics, encouraging learners to retrieve prior knowledge. Additionally, various skills are interleaved, including literacy, numeracy, scientific enquiry, methodology and data analysis and interpretation. This approach could help learners develop problem-solving skills. Assessments with interleaving reveal gaps in knowledge, enabling pathways of lessons to be tailored to individual learners, supporting them to make progress within physics. Additionally, highlighting connections across the curriculum, including connections to other sciences can be beneficial. For example, states of matter and history of the atom, are covered in both chemistry and physics, helping learners to draw comparisons, deepen understanding and apply knowledge across contexts.

How is key vocabulary embedded?

The role of language and tier three vocabulary is important in physics. That is why key vocabulary is identified in every lesson. Status and importance are given to key words, and learners are taught the meanings and definitions for subject-specific terminology. To help learners embed the vocabulary into their language, key words are modelled and used in context. Furthermore, learners can then practice understanding and applying key words in a range of questions.

How is level two vocabulary embedded?

As learners are taught key scientific concepts in physics, they encounter level two vocabulary. By reading texts and listening to information rich in knowledge, learners come across contextualised tier two words, which helps them build meaning and understanding. To further support in the comprehension of these words, learners may also be directed to a task related to the text. Level two vocabulary is also seen extensively in practice questions and, subsequently, in model answers. Since level two vocabulary is often used for direct instruction, learners are taught many tier two words as command terms in exam questions. Many of these words can be found across the curriculum within the other sciences.

What are the common misconceptions?

Some misconceptions within physics include:

- things use up energy;
- heat and temperature are the same;
- heat rises;
- a force is needed to keep an object moving;
- objects with a heavier mass will sink, objects with a lighter mass always float;
- skydivers move upwards when they open their parachute;
- batteries contain electricity;
- the battery supplies the charge to the circuit;
- current or charge is 'used up' by a component;
- all metals are attracted to magnets;
- light comes from the eyes to an object;
- gases do not have a mass;
- solid particles do not move.