



## Science Vertical Curriculum

### Science

Science is a way of understanding the richness and complexity of the world. Waldorf education recognises that there are different ways of understanding how we arrive at reliable knowledge, and that science, although it is not the only valid way, is one important aspect of this.

In the lower and middle school, science focuses on experiencing and describing phenomena. This means encountering the world, observing it, observing ourselves and what the world does to us, describing our experiences and then forming judgements about them. The Waldorf science curriculum starts holistically by being and working in the world alongside rich imaginative experiences through storytelling, so that children build their knowledge of the local natural environment and the vocabulary with which to discuss and describe it.

From class 4, there is a deepening focus on specific aspects of the life sciences, beginning with animals, then plants and eventually relating these to geology and geography. At each step we look at the particular, zoom out to set it in its context and then formulate what characterises the phenomena. As children's ability to work scientifically is developed, observations become more systematic and analytical, and they can form and justify categories.

From class 6, physics, chemistry and biology become distinct subjects, where experiments in optics, acoustics, chemistry, electromagnetism and more bring pupils into the presence of phenomena that provide sensations that excite, move and affect them; experiences that gain meaning when pupils' experiences are shared, discussed and documented, and will not easily be forgotten.

In the upper school students learn the specialist methods and terminology that each scientific discipline uses.

The Waldorf science approach is a process of meaning-making from experiences which develops conceptual understanding. It appreciates that we cannot always grasp the whole because of its complexity, so we take manageable parts, respectfully get to know them, then relate the part back into the wider context and its implications. Thus knowledge of the wider, greater whole grows step by step.

The Waldorf approach also shows that knowledge of the world has grown over a long time, with roots in many cultures such as the science of Islam in the Middle Ages, of Ancient India and China and the applied sciences of many peoples in African and the Americas before European colonization. It shows us that scientists are people from all over the world who work in teams using their skills and insights who, for example, develop vaccines in incredibly short times when we need them, develop solutions to renewable energy and resources, and help us to understand the past, predict the future and help to learn about the incredible beauty and complexity of the world.

## **Science: Purpose of Study**

Science is a way of understanding our experience of the world. The Waldorf science curriculum starts from a holistic, integrated experience of the world through focussed attention and then moves to a differentiated approach using the prism of the scientific disciplines of biology, chemistry and physics. A successful science curriculum starts with and builds on embodied experience of what is familiar to us, using observation and description of phenomena in context to generate excitement and curiosity to understand the world. Through carefully selected examples which exemplify key phenomena, pupils then build up living concepts of the natural world that are woven over time into a coherent structure of disciplinary knowledge. Throughout this process, pupils progressively learn to use and apply the scientific methods of noticing and observing; exploring, discovering and experimenting; using tools and equipment; empathic identification; understanding in context; process thinking; comparing, analysing and classifying; following processes and working systematically and rationally; recording, reporting and presenting. In the Waldorf curriculum, science also includes the study of people in different cultural and historical contexts who work/have worked systematically to understand and learn from nature (scientists). Pupils learn that scientific knowledge and progress can and should be for the benefit of humankind, and shared across countries and cultures.

## **Science: Aims**

The Waldorf curriculum for science aims to ensure that all pupils:

- develop the capability to generate understanding of scientific knowledge through study in the disciplines of biology, chemistry and physics
- can apply appropriate scientific knowledge and methods to help them to answer questions about the world around them
- have a sound basis for making informed judgements about scientific knowledge and the impact of its application in the world

## **Long Term Curriculum Intents**

### **Language and communication**

- Translating sensory experiences into language and images
- Precise and accurate description
- Remembering and using technical and scientific vocabulary
- Using scientific written language conventions, e.g. writing in the 3rd person.
- Creating models and diagrams
- Understanding and interpreting data in many forms

### **Health and well-being**

- Being confident to explore and experiment
- Using tools and equipment effectively and safely

### **Senses**

- Multi-sensory observation that is accurate and precise, without preconception, assumed prior knowledge, expectation or explanation

### **Imagination and play**

- Developing mental models of scientific concepts and processes
- Hypothesising - imagining solutions and consequences
- Changing perspective - seeing the world as a scientist

### **Empathy**

- Understanding the impact of scientific discovery and progress on others

### **Aesthetics**

- Appreciating beauty in nature and science, e.g. chemical and microscopic structures

### **Inquiry**

- Phenomenological study
- Use of relevant or related mathematical knowledge to ask and answer questions
- Accurate and precise measurement and recording
- Understanding the histories and biographies of scientists and scientific discovery
- Retaining an inquisitive mind: asking both open and specific questions.

### **Democratic participation and society**

- Understanding of the motivations for technological and scientific development, and reflecting on the political aspects scientific progress.

**Lifelong learning**

- Viewing the world scientifically
- Understanding that theories are a working model, that 'facts' are not immutable and that paradigms shift.
- Working methodically, sequentially, accurately and precisely.
- Being able to be wrong - accepting that your hypothesis was incorrect.

**Future thinking**

- Seeing science as a means of engaging with wicked problems
- Considering the impact of human development on local and global eco-systems.
- Anticipating the future and imagining the role of science in building sustainable futures.

**Holistic thinking / Spirituality**

- Understanding science in the context of social, cultural and technological development over time
- Understanding science in the context of personal lived experience
- Understanding the historical context of the relationships between people, societies, cultures, theories, beliefs and "facts".

**Judgement**

- Questioning the reliability of sources, evidence and results.
- Evaluating what is true through careful and accurate observation.
- Reflecting on the moral and ethical questions surrounding scientific progress

**Science Age-related Learning Opportunities for C1**

**Relevant Learning Descriptors**

Children should have the opportunity:  <b>Tool Use</b>	<b>Beginning Tool Use</b>
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- To learn safe use of a simple safety blade, e.g. a potato peeler (TE, PS)
- To learn how to use and care for tools used in crafting activities (PS, TE)

### **Living Things and Habitats**

- To experience the local natural environment (DE)
- To hear stories which draw their attention to aspects of the natural environment (IV, N)
- To notice aspects of and changes in the environment (N, IN)
- To recall and describe their experiences and observations orally, recording these through shared writing and/or pictures/paintings (DA, RRP)
- To explore vocabulary around parts of their own body and their senses (DA, IN)

### **Energy and Forces**

- To explore what is needed to make a fire (DE, EE)
- To understand how to stay safe around a naked flame (TE)
- To explore forces in a practical way through lifting, pushing, pulling, and using tools to multiply force (DE)

### **Materials**

- To explore the nature and potential of found natural materials (EE)

### **History and Culture**

Children can talk about how to use a simple safety blade, identifying some of the risks and mitigations, and can demonstrate their understanding in practice. They listen carefully to and follow instructions about how to use tools, and take part in ensuring that equipment is well cared for.

### **Beginning Living Things and Habitats**

Children develop a practical relationship with the living world. They can talk about the plants, animals, weather and other natural phenomena (e.g. sunlight, ice) they have experienced and observed, and their own bodies, demonstrating their knowledge and understanding of growth and change and the breadth of their vocabulary through describing, identifying and naming.

### **Beginning Energy and Forces**

Children know some of the material in their local environment that can be used to make a fire, for example identifying dry wood of a suitable size for kindling and/or banking the fire. They can talk about the heat that a fire generates, and how to keep themselves safe around a naked flame.

Children can demonstrate their practical understanding of forces through the use of their bodies and tools, applying pushes and pulls and talking about the level of force needed.

### **Beginning Materials**

Children experiment and create with found materials, e.g. creating land art and simple crafts with sticks, cones, seeds etc. They describe what they have found, and talk about where it originated, and what they can or could do with it.

### **Beginning History and Culture**

Children can explain where and when they might use a knife, and the advantages of doing so.

- To discover how a simple tool (e.g. a knife) can multiply human effort

### Science Age-related Learning Opportunities for C2

### Relevant Learning Descriptors

Children should have the opportunity:

#### Tool Use

- To learn simple knife skills and safety (TE)
- To learn how to use and care for tools used in crafting activities (TE)

#### Living Things and Habitats

- To explore the local natural environment with purpose (EE, DE)
- To observe aspects of and changes in the environment through having their attention drawn to, for example birds, animals, plants, trees, fungi, weather etc (EE, DE, N, O)
- To notice less tangible phenomena, e.g. footprints, scat, shadows etc, and talk about their causes (O, DA, IN, IV, UC)
- To recall and describe their experiences and observations orally, recording these through writing and pictures/paintings (DA, IN, RRP)
- To explore vocabulary around parts of their own body and their senses (DA, IN)

#### Energy and Forces

- To explore how to build and light a fire safely, and use it for cooking and warmth (DE, TE)

#### Early Tool Use

Children can use a knife to carry out simple tasks safely and effectively, talking about the risks and how to manage them. They listen carefully to and follow instructions about how to use new tools, and take part in ensuring that equipment is well cared for.

#### Early Living Things and Habitats

Children can identify, name and describe a variety of common plants, animals and birds in the local environment, as well as talking about the causes of some of the things they observe (e.g. footprints, shadows etc). They can talk about and record what they have observed and experienced.

#### Early Energy and Forces

Children can collect the material needed to build and light a fire, talk about fire safety, and demonstrate it in practice. They understand how the fire can be used to cook food and keep themselves and others warm.

Children can demonstrate their practical understanding of forces through the use of their bodies and tools, applying pushes and pulls and talking about the level of force needed.

#### Early Materials

<ul style="list-style-type: none"> <li>To explore forces in a practical way through lifting, pushing, pulling, and using tools to multiply force (DE, EE)</li> </ul> <p><b>Materials</b></p> <ul style="list-style-type: none"> <li>To explore the creation of useful objects from local found materials (EE, PS)</li> </ul> <p><b>History and Culture</b></p> <ul style="list-style-type: none"> <li>To discover how some everyday objects can be made from local natural materials (EE, PS)</li> <li>To discover how food can be prepared with primitive technology (PS, TE)</li> </ul>	<p>With support, children can make some useful objects from local natural materials, for example cord from nettles, or a basic shelter from branches and brackens.</p> <p><b>Early History and Culture</b></p> <p>Children can talk about how, historically, fire would have been used to cook food. They can describe the advantages and disadvantages of basic shelters, and recognise the amount of work needed to create useful buildings, objects and artefacts.</p>
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**Science Age-related Learning Opportunities for C3**

**Relevant Learning Descriptors**

<p>Children should have the opportunity:</p> <p><b>Tool Use</b></p> <ul style="list-style-type: none"> <li>To learn to use a range of building, farming and other tools safely and for a purpose (TE, PS)</li> </ul> <p><b>Living Things and Habitats</b></p> <ul style="list-style-type: none"> <li>To explore the basic needs of human beings (food, shelter, warmth) and how these needs can be met, through stories and practical experience (DE, O, IN, IV)</li> </ul>	<p><b>Developing Tool Use</b></p> <p>Children can use a range of tools safely and effectively, talking about the risks and how to manage them. They listen carefully to and follow instructions about how to use new tools, and take part in ensuring that equipment is well cared for.</p> <p><b>Developing Living Things and Habitats</b></p> <p>Children can talk about what human beings need in order to live, and how those things can be provided through working together. They can identify and name some materials in the natural environment and describe and/or demonstrate how they can be used as food or to make things. Children can talk about how plants are grown and animals reared for food, and the different processes involved in managing the environment, husbandry of</p>
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- To explore how some materials in the natural environment can be harvested and used for food or as materials for making and building (DE, N, IN)
- To explore the growing of plants and rearing of animals specifically for food, and the processes involved (DE, O, IN, DA, PS)
- To explore examples of human impact on environments, including how humans have adapted the environment and used materials to meet their needs e.g. through building, farming and traditional trades and crafts. (O, DA, IV)
- To recall and describe the stories they hear, their experiences and their observations, recording these through writing and pictures/paintings (DA, IN, RRP)

#### **Energy and Forces**

- To explore how fire can be used to transform materials, e.g. cooking or heating a dye pot (DE, TE, PS)
- To explore forces in a practical way through lifting, pushing, pulling, and using tools to multiply force (DE, EE)

#### **Materials**

- To explore building and architecture, and its relationship to available materials, traditional and local skills, and the cultural context

#### **History and Culture**

- To discover how houses and shelters were built to meet local need and conditions
- To discover how food from the local area can be grown and processed.

plants and animals, harvesting crops and producing food. They can describe a range of practical, traditional and local occupations, trades and crafts and their products (e.g. shepherd, fisherman, woodcutter, baker, tanner, weaver, blacksmith, potter). Children can discuss, recall and record their observations and experiences and the stories they have heard.

#### **Developing Energy and Forces**

With support, children can safely use fire for a purpose, e.g. to cook, and describe the processes and results that they observe. They can talk about the precautions they take to ensure their own and others' safety and demonstrate their understanding in practice. Children can talk about working together to multiply force, and how force can be applied through the use of tools, and demonstrate their understanding in practical ways.

#### **Developing Materials**

Children can describe materials, and talk about their potential and how they can be used to construct structures. They can discuss what qualities make a particular material suitable for a chosen purpose. Children understand several processes involved in construction that transform materials, for example brick making, and how to mix mortar, and can demonstrate their understanding in practical ways.

#### **Developing History and Culture**

With support, children can build a structure from the materials local to a particular culture, using traditional skills. They can talk about the impact of the environment on vernacular architecture and local foods.



## Science Age-related Learning Opportunities for C4

## Relevant Learning Descriptors

Children should have the opportunity:

### Tool Use

- To learn to use a wider range of tools safely and for a purpose (TE, PS)

### Living Things and Habitats

- To explore the wider local natural environment with purpose (DE, N)
- To observe the physical environment, and notice the impact of it on native plants and animals (O, DA)
- To notice examples of human impact (both positive and negative) on environments (O, DA)
- To create vivid mental images of animals, their habitats, and their behaviours (IV, EI, UC)
- To compare and contrast animal and human ways of moving, manipulating, sensing and reproducing, and the kinds of food that they consume. (IV, EI, CH, UC, CC)
- To explore the close relationship of all living creatures to the human being (DA, UC, CC)
- To experience a wide range of technical vocabulary specific to animals, including humans (IN, DA)
- To explore the effects of puberty on both male and female human bodies (DA, IN)

### Energy and Forces

### Progressing Tool Use

Children can use a range of tools safely, effectively and appropriately, talking about risks and how to manage them. They listen carefully to and follow instructions about how to use new tools, and take part in ensuring that equipment is well cared for.

### Progressing Living Things and Their Habitats

Children can describe the wider local environment, talking about the how it affects the plants and animals that live in it. They can discuss the positive and negative impacts that human beings have had on the local area. Children can describe a number of different animals from around the world, using accurate vocabulary, including where they live, their life cycles, what they eat and how they behave. Children demonstrate the detailed mental images that they have created through their writing, pictures, paintings and models. They can compare and contrast animals and humans, comparing the functions of human tool use with animals' anatomy, and talking about other similarities and differences. Children can describe the effects of puberty on the human body, and understand a range of ways to manage menstruation.

### Progressing Energy and Forces

With support, children can safely use a fire apparatus such as an oven or kiln. They can talk about the precautions they take to ensure their own and others' safety and demonstrate their understanding in practice. Children can talk about how force can be applied through the use of tools, and demonstrate their understanding in practical ways. They can describe the

<ul style="list-style-type: none"> <li>• To explore how fire can be harnessed and intensified to effect changes to materials (EE, TE, DE, O, DA, IN)</li> <li>• To explore forces in a practical way through lifting, pushing, pulling, and using tools to multiply force (DE, EE)</li> <li>• To explore how animals' adaptations help them to move in effective ways in different media (O, DA, IV, EI, CH, UC)</li> </ul> <p><b>Materials</b></p> <ul style="list-style-type: none"> <li>• To explore how materials can be processed with heat, e.g. firing clay, cooking bread (N, O, IN)</li> <li>• To explore how local materials have been processed in traditional industries, e.g. charcoal, pottery (N, DA, IV)</li> <li>• To explore a craft of the teacher's choosing, depending on available skills and resources</li> </ul> <p><b>History and Culture</b></p> <ul style="list-style-type: none"> <li>• To explore the connections between local environment and industrial history (N, O, DA, IV)</li> <li>• To explore the history of the development of writing (DE, TE, PS)</li> </ul>	<p>ways in which different animals move on land, in the air and through water, and how their body shape and size makes this easier or harder.</p> <p><b>Progressing Materials</b></p> <p>Children can describe the changes that occur in materials which have been subjected to intense heat, using accurate vocabulary. They can talk about raw materials that are available in the local environment, how these were processed, and how the products were used. If available skills and resources allow, children can learn some basic methods and techniques to transform a material through additional craft teaching.</p> <p><b>Progressing History and Culture</b></p> <p>Children can talk about local historical industries and their connection to the local natural environment and available resources. With support and instruction they can make a functioning pen and usable paper, and talk about the sequence of processes involved.</p>
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### Science Age-related Learning Opportunities for C5

### Relevant Learning Descriptors

<p>Children should have the opportunity:</p> <p><b>Tool Use</b></p> <ul style="list-style-type: none"> <li>• To learn to use a range of tools safely and skilfully (TE, PS)</li> </ul>	<p><b>Competent Tool Use</b></p> <p>Children can use a range of tools safely, effectively and appropriately, talking about risks and how to manage them. They have refined their practical skills in whittling and carving, creating useful objects. Children listen carefully to and follow instructions about how to use new tools, and</p>
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- To practise whittling and carving skills on green wood (TE)

### **Living Things and Habitats**

- To explore different biomes (DE, N, O, DA, IN)
- To carry out observation-based study of flowering plants in their environment (DE, O, DA, IN, IV, EI, CH, UC)
- To explore the process transformation from seed to flower and fruit (IN, IV, EI)
- To explore a range of trees and plants in the local environment, and where they grow (DE, N, O, DA, IN, UC)
- To explore the relationship between plants and their environment, looking at plants around the world in a range of landscapes and climates (DA, IN, IV, EI, UC, CH)
- To explore some of the relationships between plants and insects (DA, IN, IV)
- To explore some of the ways in which plants have been and still are used (e.g. dyes, medicines etc) (DA, IN, UC)
- To create vivid mental images of groups of animals, their habitats and their behaviours (IV, EI, UC, CC, CH)
- To compare and contrast a number of types of animals within a group, including their specialisms, their feeding habits and how they raise their young. (DA, IN, UC, CH, CC, FC, LC)
- To explore the organisations of social insects (e.g. bees, ants) and the life cycle and metamorphosis of insects (e.g. butterflies) (DA, IN, IV, EI, UC)
- To explore the importance and uses of insects for humans, and the balance of population growth and control. (DA, IN, UC)
- To explore issues of biodiversity and climate change. (DA, EI, UC)

### **Materials**

take part in ensuring that equipment is well cared for. They take pride in their work.

### **Competent Living Things and Habitats**

Children can talk about a range of relatively local biomes, describing their different soils, crops, habitations and wild spaces. They observe, describe, identify and name a number of individual trees and plants in their local environment, demonstrating their knowledge through detailed drawings which show an appreciation of the beauty of the plant, as well as the structure. Children can identify, name and describe a number of plants growing in different locations and conditions in the local environment. They can talk about the different kinds of plants that grow in different landscapes and climates, describing how they are affected by sun, air, soil, temperature and water supply. Children can explain some of the ways in which plants and insects are important to one another, and some of the ways in which humans have used plants in the past and still use them today.

Children demonstrate the detailed mental images that they have created of groups of animals through their writing, pictures, paintings and models. They can identify the similarities and differences of animals within a group talking about how they have been categorised. Children can describe the complex social behaviour of examples of insect colonies, and the individual specialisations within the organisation. They can talk about how humans rely on insects for pollination and the breaking down of waste, and how their populations can be controlled through insecticides and other, more organic methods. Children can talk about the impact of human beings on biodiversity, and some of the ways in which climate change has been accelerated by human activity.

### **Competent Materials**

Children can imagine the potential of a material and how it could/can be transformed through the use of tools. If available skills and resources allow,

<ul style="list-style-type: none"> <li>To explore how materials can be adapted through skilled tool use (EE, TE, PS, DE)</li> <li>To explore a craft of the teacher's choosing, depending on available skills and resources</li> </ul> <p><b>History and Culture</b></p> <ul style="list-style-type: none"> <li>To begin to explore the idea of being a craftsperson and the development and application of physical skill. (DE, EI)</li> </ul>	<p>children can learn some further methods and techniques to transform a material through additional craft teaching.</p> <p><b>Competent History and Culture</b></p> <p>Children demonstrate their appreciation of the concept of being a craftsperson through taking care with their work, and taking pride in what they produce.</p>
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**Science Age-related Learning Opportunities for C6**

**Relevant Learning Descriptors**

<p>Children should have the opportunity:</p> <p><b>Zoology</b></p> <ul style="list-style-type: none"> <li>To learn about different animal species, their behaviour and reproductive cycles, including humans. (RRP, DA, IN, IV, EI, UC, CH, CC, AC)</li> <li>To learn about the structure of the primary sexual organs, biological sex and gender identity and expression. (RRP, DA, IN, IV, UC, CH)</li> <li>To learn about different insect species, their life cycles, their behaviour, and how this impacts their environment. (RRP, DA, IN, IV, EI, UC, CH, CC, AC)</li> </ul> <p><b>Botany</b></p>	<p><b>Secure Zoology</b></p> <p>Pupils can describe, compare and contrast different animal species, their characteristics, behaviour, environment, life lines, reproductive cycles and the raising of young. They can research and write/talk about other chosen species. Pupils understand sex in humans both as a means of reproduction, and as a positive aspect of a healthy intimate relationship. They can describe the difference between biological sex and gender identity and expression. Pupils can identify common insect types. They can describe and illustrate the life cycle of a number of species including, for example, butterflies, beetles, bees, ants and/or termites. They can describe the significance of the relationship between insects and flowering plants, their relationship with their environment, and explain some of the implications of this for people.</p> <p><b>Secure Botany</b></p> <p>Building on Class 5 Pupils can observe, describe, identify and name a number of additional flowering plants in their local environment,</p>
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- To learn about some additional familiar flowering plant types and their life cycles through the year. (RRP, DE, O, DA, IN, IV, EI, UC, CH, CC, AC)
- To learn about a range of indigenous and exotic trees, their main characteristics, their impact on their environment, and their uses for people. (RRP, DE, O, DA, IN, IV, EI, UC, CH, CC, AC)
- To learn about the history and character of different types of hedgerows, and their impact on the environment. (RRP, DE, O, DA, IN, IV, EI, UC, CH, CC, AC)
- To learn about the geographical, historical and cultural significance of a range of trees and forests. (RRP, DA, IN, IV, EI, UC, CH, CC, AC)

#### **Tool and Equipment Use**

- To use a range of equipment appropriate to the activity (EE, TE)
- If resources allow, to experience the safe use of scientific equipment, e.g. a Van der Graaf generator (EE, TE)

#### **Sound**

- To explore the acoustic properties of a wide range of different materials; the connection between vibration and sound, e.g. using a tuning fork; (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, CH, PT, FC, LC, CC, AC, OO)
- To explore the relationship between size or amount of vibrating body and pitch (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)
- To explore transmitting sound through different materials (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)
- To explore sound over distance (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)

demonstrating their knowledge through detailed drawings which show an appreciation of the beauty of the plant, as well as the structure. Children can identify a number of different tree types, both local and exotic, their main characteristics, their impact on the environment and their use for people. They can describe a range of typical hedgerow plants, talk and/or write about hedgerows as a habitat, and describe some of the benefits of retaining hedgerows in the farmed environment.

Children can describe and write about the benefits of forests and the risks associated with clearing forests and de-forestation.

#### **Secure Physics Tool Use and Equipment**

Pupils can follow instructions with thought and care, and talk about the risks associated with equipment and activities. They can name and use a range of equipment appropriate to the activity.

#### **Secure Sound**

Pupils can describe how the quality of a sound produced by an object gives information about the consistency of the material it is made from, and how the qualities of the material affect the pitch of the sound. They can describe the effectiveness of different materials in conducting sound. Pupils can give a good estimate of the speed of sound, and describe how this might change depending on atmospheric conditions. Pupils can describe how hollow bodies resonate differently in specific ways, explain that sound is material in motion, and give examples of how resonance can be made visible.

#### **Secure Light**

Pupils can explain that objects are only visible when and where there is light – that we do not see light itself, only the surface it shines on. They can describe how the visibility of an object is dependent on its transparency/opacity, and that shadows are an absence of light. Pupils can

- To explore the phenomenon of resonance (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)
- To experience monochords and Chladni plates (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)

### Light

- To experiment with darkness and light (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, DC, CH, FC, LC, AC, OO)
- To explore transparency and opacity (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)
- To experiment with objects and light sources to create shadows (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)
- To explore the how light reflects from a smooth, shiny surface, e.g. a mirror (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)
- To make a pinhole camera (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)
- To explore how light can be refracted, for example by water. (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)

### Thermo-dynamics

- Explore, describe and characterise temperatures and heat sources in everyday life, including natural forms of heat such as body heat, sunlight etc. (EE, TE, RRP, DE, N, O, DA, IN, IV, EI, UC, CH, OO)
- Explore the impact of the reduction of temperature, for example, the formation of ice on water in winter. (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)

explain that light travels in straight lines, and that where it is reflected, the angle of incidence is equal to the angle of reflection. They can describe what happens when light is refracted.

### Secure Thermo-dynamics

Pupils can describe how heat enlivens materials and brings them into movement, and how cold makes them more static, but can also preserve them. They can explain that different materials conduct and retain heat at different rates.

### Secure Electricity and Magnetism

Pupils can explain that we cannot directly perceive electricity, but we can produce it and see its effects. Pupils can describe and illustrate the concept of electrical charge and potential, describing how an electrical charge can be produced by bringing certain materials into relationship with each other. They can talk about the difference between conducting and insulating materials. Pupils can explain that magnetism is a force – we cannot directly perceive its cause, but we can perceive its effects.

Pupils can explain which materials are magnetic, and describe how magnetism can be used to identify materials. They can deduce the principles of repelling and attracting poles.

<ul style="list-style-type: none"> <li>Experiment with the effect of heat on and through materials (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)</li> </ul> <p><b>Electricity and Magnetism</b></p> <ul style="list-style-type: none"> <li>Explore evidence of magnetism and static electrical charge (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)</li> <li>Explore the distinction between conductive and insulating materials (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)</li> <li>Explore the properties of conducting and insulating materials (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, DC, CD, CC, AC, OO)</li> <li>Explore how magnetic poles attract and repel one another. (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)</li> </ul>	
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**Science Age-related Learning Opportunities for C7**

**Relevant Learning Descriptors**

<p>Children should have the opportunity:</p> <p><b>Human Biology</b></p> <ul style="list-style-type: none"> <li>To explore the digestive organs and processes, food substances (carbohydrates, protein, fat, vitamins etc and food additives) and diets. (EE, TE, RRP, PS, DE, O, DA, IN, UC, PT, CH, CC, AC)</li> <li>To explore different food cultures. (RRP, DA, IV, EI, UC, CC)</li> <li>To explore and experience processes of respiration and circulation. (RRP, PS, O, DA, IN, IV, EI, UC, PT, CH)</li> <li>To learn about the functions, functioning and symbolism of the heart. (RRP, DA, IN, IV, UC, PT, CH)</li> <li>To learn about the structure, function and care of the skin, hair and fingernails. (RRP, DA, IN, IV, UC, PT, CH)</li> </ul>	<p><b>Proficient Human Biology</b></p> <p>Pupils have a foundational and practical understanding of the functions of the different organs and systems of the human body and their relationship to the organism as a whole. They can talk about a number of common disorders of these organs/systems, and their relationship to health. Pupils can give an outline of the digestive process from sight/smell to excretion and beyond. They can relate this knowledge to an understanding of food, food types, food quality and eating behaviour. They can compare and contrast a range of food cultures. Pupils can give an outline of the processes of respiration and circulation, and the role of the heart and lungs. They can talk about the symbolism of the heart in different cultures. Pupils can write about and/or illustrate the structure of the skin, and several of its functions. They can describe some skin and hair types, and</p>
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- To learn further about the biology of and different cultural attitudes towards sexual organs and sexual characteristics, reproduction and sexuality. (RRP, DA, IN, IV, UC, PT, CH)
- To learn about contraception, sexual health and consent. (RRP, DA, IN, IV, UC, PT, CH)
- To learn about the nerve-sense system and the brain. (RRP, DA, IN, IV, UC, PT)
- To explore the senses of balance, sight, hearing, taste and temperature. (RRP, DA, IN, IV, UC, PT, CH)
- To explore the nature of health, and the impact of disease and disorder. (RRP, DA, IN, IV, UC, PT)
- To explore a range of factors that promote or limit physical and mental health. (RRP, DA, IN, IV, UC, PT)
- To learn about medicine, its history, and a range of approaches to promoting health and wellbeing, and managing disease, illness and disorders. (RRP, DA, IN, IV, UC, PT)

### Chemistry

- To safely explore the combustion of a wide range of familiar materials (EE, TE, RRP, PS, DE, N, O, DA, IN, UC, PT, CH, FC, LC, CC, AC, OO)
- To safely explore the combustion of unfamiliar materials in laboratory conditions, e.g. magnesium underwater etc (EE, TE, RRP, PS, DE, N, O, DA, IN, UC, PT, CH, FC, LC, CC, AC, OO)
- To observe the factors which enhance and inhibit combustion (EE, TE, RRP, PS, DE, N, O, DA, IN, UC, PT, CH, FC, LC, CC, AC, OO)
- To record their observations in writing, diagrams and pictures (RRP, PS)
- To experiment with indicators (e.g. beetroot juice, litmus paper, universal indicator solution etc) (EE, TE, RRP, PS, DE, N, O, DA, IN, UC, PT, CH, FC, LC, CC, AC, OO)

how these are cared for in different cultures. Pupils can describe human sexual organs, and primary and secondary sexual characteristics, both visible and invisible. They can give an outline of the process of reproduction. Pupils can describe a number of common methods of contraception, and talk about how to keep sexual relationships safe and consensual. Pupils can give an outline of the nerve-sense system, and the brain as a monitoring organ at the centre of this system. They can talk about senses as a way of perceiving the world, and the restrictions of sensory limitations (e.g. visual impairment, hearing impairment, effects of alcohol on balance etc).

### Proficient Chemistry Tool Use and Equipment

Pupils can follow instructions with thought and care, and talk about the risks associated with equipment and activities. They can name and use a range of equipment appropriate to the activity.

### Proficient Chemistry

Pupils can describe and explain the processes of combustion of familiar and unfamiliar materials, and talk about the implications this has for practical life and fire safety. They can observe carefully and accurately describe the experiments that they have done or observed, and record their understanding in text, diagrams and illustrations. Pupils can experimentally test for acids and bases, using simple indicators and scales. They understand and can apply the formula of acid + base  $\rightarrow$  salt + water, and give examples of practical application of this in everyday life.

Pupils can talk and/or write about common metals, their properties, their origins and their uses. They can describe a range of positive benefits and possible environmental consequences of the mining and petro-chemical industries.

### Mature, Independent Physics Tool Use and Equipment



- To burn lime in a kiln and slake the resulting residue (EE, TE, RRP, PS, DE, N, O, DA, IN, UC, PT, CH, FC, LC, CC, AC, OO)
- To deduce that acid +base -> salt + water (EE, TE, RRP, PS, DE, N, O, DA, IN, UC, PT, CH, FC, LC, CC, AC, OO)
- To explore the qualities of different common metals, their origins, forms of production, their cultural history and their technological applications (EE, TE, RRP, PS, DE, N, O, DA, IN, UC, PT, CH, FC, LC, CC, AC, OO)
- To explore the benefits, risks and impact of the mining and petro-chemical industries. (RRP, O DA, IN, IV, EI, UC, CH, OO)

#### **Tool and Equipment Use**

- To use a range of equipment appropriate to the activity (EE, TE)
- To use a range of equipment appropriate to the activity (EE, TE)

#### **Electricity and Magnetism**

- To experiment with copper and zinc plates to generate charge and create circuits. (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)
- To experiment with voltage and resistance. (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)
- To discuss the nature of electrical charge and potential. (DA, IN, IV, EI, UC, CH, FC, LC, AC, OO)
- To explore the properties of magnets, including magnetic fields, and the application of this in technology. (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)

#### **Sound**

Pupils can follow instructions with thought and care, and talk about the risks associated with equipment and activities. They can name and use a range of equipment appropriate to the activity.

#### **Mature, Independent Electricity and Magnetism**

##### Electricity

Pupils can describe and illustrate diagrammatically the nature of electrical current in a closed circuit. They can explain that using different metals results in different voltages. Pupils can describe electrical resistance, and its effects on voltage. They can describe how a light bulb works. Pupils can infer the nature of electricity as a dynamic relationship, rather than the flow of a substance.

##### Magnetism

Pupils can describe and illustrate the main properties of magnets, magnetic fields and their application.

#### **Mature, Independent Acoustics**

Pupils can describe the impact of distance, volume and pitch on what they are able to hear. They can describe and illustrate the nature of sound as vibration, and how this can be measured, recorded and applied in technology and in the natural world.

#### **Mature, Independent Information Technology**

Pupils can describe and write about the history of communication technologies from semaphore to smartphone, including the recording and transmission of sound and data.

#### **Mature, Independent Mechanics**

- To explore the limits of human hearing. (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)
- To explore acoustic properties of different materials and their applications. (EE, TE, RRP, PS, DE, O, DA, IN, UC, PT, CH, FC, LC, CC, OO)
- To explore the measurement of sound frequencies. (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)
- To explore the nature and use of echoes both in the natural world and by humans. (RRP, DA, IN, IV, EI, UC, PT, CH, CC, OO)

#### **Information Technology**

- To explore different recording technologies. (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, OO)
- To explore the history of communications technologies and computing to the present day. (RRP, O, DA, IN, IV, UC, CC, AC, OO)

#### **Mechanics**

- To explore the impact of inclined planes and shapes on velocity (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)
- To explore the nature and principles of levers, wedges, winches, pulleys and screws. (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)
- To explore the bending and resilience of different materials. (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)

#### **Light**

- To explore the reflection and projection of light. (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)

Pupils can explain why different shapes travel at different rates down an incline. Pupils can deduce and describe simple principles of leverage, and use formulae to calculate leverage. They can describe different classes of levers. Pupils can explain the principles of pulleys and gears, and describe their practical uses. They can calculate the velocity ratio. Pupils can describe the flexibility of different materials and how this can be used in practice.

#### **Mature, Independent Light**

Pupils can describe and illustrate how light makes things visible, and has an impact on our perception of them, e.g. colour and shadow. They can explain that light travels in straight lines and describe how it is reflected from smooth, irregular and curved surfaces.

#### **Mature, Independent Thermodynamics**

Pupils can describe the effects of heating and cooling on different substances, and how these properties can be used. They can describe the insulating and conductive properties of different materials, and how this can be used. Pupils can describe the history and relationship of the petrochemical industry and the combustion engine, and the impact of these on the environment.

<ul style="list-style-type: none"> <li>To discuss the nature and characteristics of light. (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)</li> </ul> <p><b>Thermo-dynamics</b></p> <ul style="list-style-type: none"> <li>To explore the phenomenon of warmth in the expansion and contraction of different substances; the experience of this and its uses. (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)</li> <li>To explore the history of the petrochemical industry, the combustion engine, and the applications and environmental consequences of these. (RRP, DA, IN, IV, EI, UC, CH, CC, OO)</li> </ul>	
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**Science Age-related Learning Opportunities for C8**

**Relevant Learning Descriptors**

<p>Children should have the opportunity:</p> <p><b>Human Biology</b></p> <ul style="list-style-type: none"> <li>To explore the mechanics and physical potential of how their bodies move. (RRP, DE, N, O, DA, IN, IV, UC, PT, CH, CC, AC, OO)</li> <li>To explore the relationships between bipedalism, the shape of the pelvis and the maximum size of a baby's head. (RRP, DA, IN, IV, UC, PT, CH, CC, OO)</li> </ul> <p><b>Chemistry</b></p> <ul style="list-style-type: none"> <li>To explore the process from cereal to bread, and the qualities of the material at the various stages. (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, UC, PT, CH, CC, AC, OO)</li> </ul>	<p><b>Mature, Independent Human Biology</b></p> <p>Pupils can write about and illustrate the bones and muscles of human limbs, torso and head. Pupils can describe how they move, the mechanics involved and the expressive, aesthetic and physical opportunities our bodies give us. They can describe the connections between skeletal shape, the mechanics of birth, and brain development.</p> <p><b>Mature, Independent Tool Use and Equipment</b></p> <p>Pupils can follow instructions with thought and care, and talk about the risks associated with equipment and activities. They can name and use a range of equipment appropriate to the activity.</p> <p><b>Mature, Independent Chemistry</b></p> <p>Pupils can describe and compare a range of starches and sugars, their origins, production processes, and their properties at various stages of</p>
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- To explore other starches, their properties and uses. (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, UC, PT, CH, CC, AC, OO)
- To explore the origins, nature and uses of sugars, and its effects on the human body (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, UC, PT, CH, CC, AC, OO)
- To explore the chemistry of sugars; explore fermentation and decay. (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, UC, PT, CH, CC, AC, OO)
- To explore the chemistry, production and usage of cellulose and esters, and the uses and abuses of alcohol (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, UC, PT, CH, CC, AC, OO)
- To learn in a simple way about the production of glucose in plants through photosynthesis (RRP, DA, IN, IV, EI, UC, PT, OO)
- To discover the origins, nature and uses of protein, and its effects on the human body (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, UC, PT, CH, CC, AC, OO)
- To explore the qualities of fats and oils (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, UC, CH, PT, CC, AC, OO)
- To explore the production and qualities of milk, cheese and yoghurt (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, UC, CH, PT, CC, AC, OO)
- To discover the biographies of eminent food scientists, e.g. Louis Pasteur, Elsie Widdowson (RRP, IV, EI, UC)

#### **Tool and Equipment Use**

- To use a range of equipment appropriate to the activity (EE, TE)

#### **Hydraulics**

- To explore hydraulic phenomena, including the Archimedes principle, hydrostatic buoyancy, pressure and compression, specific weight and the application of these principles in tools and

refinement. They can talk and/or write about starches and sugars in human diets, how they are used by the human body and the implications for health. Pupils know how to test for sugar and starch, and can demonstrate their understanding practically. In a simple way, they can explain the processes of fermentation and decay. Pupils can describe in a simple way how glucose is produced in plants through photosynthesis. Pupils can describe and compare the origins, nature and uses of a range of proteins, fats and oils. They can talk and/or write about proteins, fats and oils in human diets, how they are used by the body and the implications for health. Pupils can talk and/or write about some eminent food scientists, their discoveries and the implications of these on modern foods and diets.

#### **Hydraulics**

Pupils can describe and explain the hydraulic and aero-mechanic phenomena of the Archimedes principle, hydrostatic buoyancy, pressure and compression, specific weight, pumps, suction and aerodynamics. They can describe a number of practical applications of these principles, e.g. hydraulic tools, submarines, plungers etc.

#### **Meteorology**

Pupils can describe a wide variety of weather phenomena, their causes and consequences. They can explain how weather data can be collected and used for forecasting and describe the history and economic advantages of this. Pupils can relate this information to the realities and consequences of climate change.

technology. (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)

**Meteorology**

- To observe and learn about different weather phenomena and their consequences. (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)
- To explore the possibilities and technologies of weather data recording and weather forecasting, and their history. (EE, TE, RRP, PS, DE, N, O, DA, IN, IV, EI, UC, PT, CH, FC, LC, CC, AC, OO)