Year 5 Science Curriculum

The National Curriculum for science intends that children's understanding of the nature, processes and methods of science is developed through different types of science enquiries that help them to answer scientific questions about the world around them. Within each year group, substantive (knowledge) content should be taught through practical opportunities that enable children to develop a range of 'Working Scientifically' skills. These skills, from the National Curriculum, are provided below and are then exemplified in relation to each science unit.

Year 5/6 Working Scientifically Skills			
Plan	**Do**	**Record**	**Review**
• Plan different types* of scientific enquiries to answer their own questions, including recognising and controlling variables where necessary. • Use test results to make predictions to set up further comparative and fair tests. • **Types of enquiry including: observing changes over time, noticing patterns, grouping and classifying, comparative and fair tests, using secondary sources.* ***Pupils in years 5 and 6 should use their science experiences to:*** • *Explore ideas and raise different kinds of questions;* • *Select and plan the most appropriate type of scientific enquiry to use to answer scientific questions;* • *Recognise when and how to set up comparative and fair tests and*	Use a range of scientific equipment to take accurate and precise measurements or readings, with repeat readings where appropriate *They should use and develop keys and other information records to identify, classify and describe living things and materials, and identify patterns that might be found in the natural environment.* *They should make their own decisions about what observations to make, what measurements to use and how long to make them for, and whether to repeat them; choose the most appropriate equipment to make measurements and explain how to use it accurately.*	• Record data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar, and line graphs. • Report and present findings from enquiries, including conclusions and causal relationships, in oral and written forms such as displays and other presentations, using appropriate scientific language. • *They should decide how to record data from a choice of familiar approaches;*	• Explain degree of trust in results. • Identify and evaluate scientific evidence (their own and others') that has been used to support or refute ideas or arguments. • Describe and evaluate their own and others' scientific ideas related to topics in the national curriculum (including ideas that have changed over time), using evidence from a range of sources. • Draw conclusions, explain, and evaluate their methods and findings, communicating these in a variety of ways. • Raise further questions that could be investigated, based on their data and observations. • *They should look for different causal relationships in their data and identify evidence that refutes or supports their ideas.* • *They should use their results to identify when further tests and observations might be needed; recognise which secondary sources will be most useful to research their ideas and begin to separate opinion from fact.*

explain which variables need to be controlled and why.			• *They should use relevant scientific language and illustrations to discuss, communicate and justify their scientific ideas and should talk about how scientific ideas have developed over time.*

Statutory content is specified below and is supported by reference to non-statutory guidance. Non-statutory guidance is shown in *italics*
The six main types of enquiries are highlighted within each unit to ensure appropriate coverage across each year group:

Observing over time	Pattern Seeking	Identifying, Classifying and Grouping	Comparative and Fair testing	Researching using secondary sources	Exploring

Unit and Vocabulary	Intent - statutory and non-statutory *(in italics)* content – Substantive (knowledge)	Intent –statutory and relevant non-statutory *(in italics)* content-Disciplinary (skills)
Living things and their habitats Pond, garden, field, park, woodland, sea shore, river, ocean, forest, rainforest, stones, rocks, logs, leaf litter Habitat, micro-habitat, living, dead, not living, alive, healthy, food, food chain, depend, source of food, shelter, grow, growth, healthy, environment, non-flowering plants, ferns, mosses, flowering plants, grasses vertebrate animals: fish, birds, mammals, amphibians, reptiles, invertebrate animals: snails, worms, slugs, spiders, insects human impact – litter, deforestation, population increase, nature reserves **<u>New Vocabulary</u>** **Life cycle, reproduction/reproduce, life processes, sexual/asexual reproduction (plants), sperm, fertilises, egg, live young, metamorphosis, asexual, plantlets, runners, bulbs, root, cuttings, classification**	***This topic should be taught throughout the year.** **Pupils should be taught to:** • describe the differences in the life cycles of a mammal, an amphibian, an insect, and a bird. • describe the life process of reproduction in some plants and animals. ***Pupils should study and raise questions about their local environment throughout the year.*** • *They should observe life-cycle changes in a variety of living things, for example, plants in the vegetable garden or flower border, and animals **in the local environment.*** • *They should find out about the work of naturalists and animal behaviourists, for example, David Attenborough and Jane Goodall.* • *Pupils should find out about different types of reproduction, including sexual and asexual reproduction in plants, and sexual reproduction in animals.*	**Pupils should be taught to:** • report and present findings from enquiries, including conclusions and causal relationships, in oral and written forms such as displays and other presentations, using appropriate scientific language.

Implementation-activity examples and cultural capital opportunities	**Observing over time** • Grow and observe plants that reproduce asexually e.g., strawberries, spider plants, potatoes. • Plant bulbs and then harvest to see how they multiply. • Make first-hand observations of the life-cycles of a range of animals e.g. chickens, butterflies, snails, frogs, brine shrimps. Brine shrimp eggs can be easily purchased from a range of online suppliers. See the CLEAPSS guidance about keeping tadpoles/snails. Key questions • **How do potato plants grow and reproduce?** • **Were there any changes when we harvested our bulbs?** • **How do chickens/butterflies/snails change and develop*?*** **Pattern Seeking** • Compare the gestation times for mammals and look for patterns e.g., in relation to size of animal or length of dependency after birth. • Look for patterns between the size of an animal and its expected life span. Key questions • **Is there a relationship between the size of a mammal and its gestation period?** • **Is there a relationship between the size of a mammal and how long its young are dependent after birth***?* **Identifying and Classifying** • Give pupils pictures of a collection of animals and ask them to compare/sort them based on similarities and differences in their lifecycle. Key questions • **What are the similarities and differences in the lifecycles of these animals?** • **How could you sort these animals based on their lifecycles?** **Comparative and Fair Testing** • Change the conditions that brine shrimp eggs are in (e.g., the amount of salt) and observe the impact this has on hatching time. Key question • **How does the amount of salt affect how quickly brine shrimp hatch?** **Researching using secondary sources** • Use secondary sources to find out about pollination. • Research the differences between the lifecycle of an insect/mammal, bird/fish etc. Key questions • **What are the differences between the life cycle of an insect and a mammal?** • **What is the process of pollination***?*

Exploring and Problem Solving

- Explore unusual lifecycles e.g., Marsupials, Seahorses or egg laying mammals like Platypuses/Echidnas.
- Explore the lifecycles of a range of mammals, insects, fish and birds.
- Explore ways of presenting different lifecycles including using drawings, drama and making models.
- Explore ways of presenting the process of pollination including using drawings, drama and making models.
- Explore the question, *which pollinators visit our school grounds?* See Explorify for more information, https://explorify.uk/en/activities/the-big-question/which-pollinators-visit-our-school-grounds
- Based on their learning, challenge pupils to think of new questions they'd like to investigate about living things and their habitats – where possible enable them to do investigations to answer them.

Key questions

- **What is the lifecycle of a platypus? How is this different to other mammals?**
- **What are the similarities/differences between the lifecycles of a horse and an elephant? A blue tit and a Golden Eagle?**

Cultural capital opportunities

Sustainable Development Goals: 13 Climate Action, 14 Life below land, 15 Life on land
Climate change links: Learn about the impact that climate change is having on the lifecycle of animals and plants. Explore how the early onset of spring negatively impacts the life cycle of animals and plants.
Visits/trips: A local zoo or wildlife centre. A botanic garden or garden centre/nursery. An arable farm
Visitors: A biologist, zoologist, or vet. A gardener/farmer. See Encounter Edu, https://encounteredu.com/.
See Farmer Time https://leaf.eco/farmertime/home . See STEM Ambassadors, https://www.stem.org.uk/stem-ambassadors for help with finding visitors.
Scientists: James Brodie of Brodie (Reproduction of Plants by Spores)
David Attenborough (Naturalist and Nature Documentary Broadcaster)
***Make sure pupils are exposed to a diverse range of scientists including scientists who are working today. See,**

- **The PSTT** https://pstt.org.uk/resources/curriculum-materials/ASJLM **&** https://pstt.org.uk/resources/curriculum-materials/Science-at-Work
- **The Ogden Trust** https://www.ogdentrust.com/resources/research-cards-women-in-physics
- **STEM Sisters** http://www.hmdt.org.uk/hmdtmusic/stemsisters/the-stem-sisters-2/
- **Oxford Sparks** https://www.oxfordsparks.ox.ac.uk/justaddimagination **for resources to support this.**

Enrichment experiences:

- Pupils could rear animals from young to adulthood e.g., chicks.
- Pupils could keep tadpoles or caterpillars and observe their lifecycle.
- Pupils could keep native species of snail and observe their lifecycle from egg to fully grown snail.

Subject Links	

English

- Pupils write their own version of 'The Tadpole's Promise by Jeanne Willis.
- Pupils write a story based on the life cycle of an animal inspired by stories like 'The Very Hungry Caterpillar' by Eric Carle or 'The Tadpoles Promise'.

Related texts

- The Land of Neverbelieve, (Norman Messenger)
- Mummy Laid an Egg, (Babette Cole)
- Tadpole's Promise—Jeanne Willis & Tony Ross
  - **What are the similarities and differences in the life cycles of a frog and a butterfly?**
  - **What other insects go through metamorphosis?**
- Cicada—Shaun Tan
  - **How is a real cicada's life cycle similar/different to the one in the story?**
- The Boy in the Tower—Polly Ho-Yen
  - **How do different plants reproduce?**
  - **Which plants reproduce using spores?**

Maths

- Measure and compare the growth rates of different plants.
- Measure the increase of mass in potatoes when they are harvested.
- Convert gestation times for different animals into hours/seconds.

Computing/Technology

- Present information about life cycles using PowerPoint or Google Slides.
- Make simple stop-frame animations to show the life cycles of animals.

DT

- Make models to show the life cycles of animals.

Geography

- Learn about where different animals are found in the UK/ world.

Unit and Vocabulary	Intent - statutory and non-statutory *(in italics)* content – Substantive (knowledge)	Intent –statutory and relevant non-statutory *(in italics)* content-Disciplinary (skills)
Animals including humans names of common animals: fish, amphibians, reptiles, birds, mammals, carnivores, herbivores, omnivores, human, body, senses, see, hear, feel, smell, taste, habitat, local environment, pet, wild animal, insect, minibeast, food, eat, head, neck, body, arms, legs, ears, eyes, nose, mouth, tongue, hands, feet, fingers, toes, elbows, knees, hair, teeth grow, healthy, offspring, adults, young, water, air, survive, exercise, hygiene, egg, chick, chicken, caterpillar, pupa, moth, butterfly, tadpole, frog, frog spawn, lamb, sheep, calf, cow, foal, horse, nutrition, diet, skeleton, muscles, protection, support, movement, bones skull, shell, digestive system, stomach, small intestine, large intestine, oesophagus types of teeth: molar, premolar, incisor, canine saliva **New Vocabulary** **Puberty, gestation period, embryo**	**Pupils should be taught to:** • describe the changes as humans develop to old age. • *Pupils should draw a timeline to indicate stages in the growth and development of humans. They should learn about the changes experienced in puberty.*	**Pupils should be taught to:** • report and present findings from enquiries, including conclusions and causal relationships, in oral and written forms such as displays and other presentations, using appropriate scientific language.

Implementation-activity examples and cultural capital opportunities	**Observing over time** • Look at pictures of different animal's embryos and observe how they change over time. Key question • **How do different animal embryos change?** **Pattern Seeking** • Measure the height of everyone in the class and identify any patterns. • Measure pupils from different year groups and identify any patterns. • Measure the handspans of pupils in the class. Key questions • **Are the oldest pupils in our class/school the tallest?** • **Does the tallest person have the widest handspan?** **Identifying and Classifying** • Use photographs to identify the different stages of the human life cycle. Key question • **Can you identify all the stages in the human life cycle?** **Comparative and Fair Testing** • Test the reaction times of differently aged people including adults and identify any patterns in the data. Reaction times can be tested using a ruler. Reaction rulers that can be printed off and stuck to card can be found at https://www.stem.org.uk/resources/elibrary/resource/34386/campus-science-science-busking-pack and https://www.stem.org.uk/resources/elibrary/resource/34277/stupendous-steppers-ages-5-7-suitable-home-learning#&gid=undefined&pid=7 • Measure the height of everyone in the class. Re-measure regularly and compare growth rates between boys and girls. Key questions • **How does age affect a human's reaction time?** • **Who grows the fastest, girls or boys?** **Researching using secondary sources** • Research average life expectancy in different countries and how this has changed significantly in the last hundred years. • Research what happens to the human body as it ages. Key questions • **How has average life expectancy changed in the UK?** • **How does average life expectancy in the UK compare to other countries?** • **Why do people get grey/white hair when they get older?**

	Exploring and Problem Solving • Explore the impacts that an aging society will have and how we can stay fit and healthy into old age. See Explorify, https://explorify.uk/en/activities/the-big-question/how-can-we-stay-fit-and-healthy-as-we-get-older • Through a whole class discussion explore, 'what if the average life-span of a human was 200?' See Explorify, https://explorify.uk/en/activities/what-if/the-average-lifespan-of-a-human-was-200 • Based on their learning, challenge pupils to think of new questions they'd like to investigate about humans – where possible enable them to do investigations to answer them. Key question • **How can we stay fit and healthy as we get older?** **Cultural capital opportunities** **Sustainable Development Goals** **Climate change links:** Learn about the impact that climate change might have on average human life expectancy. **Visits/trips**: A local day care centre for the elderly. **Visitors:** An elderly person. **Scientists:** Dr Steve Jones (Geneticist) Prof Robert Winston (Human Scientist)
Subject Links	**English** • Write a short science fiction based on the premise, *'what if everyone stopped aging?'* Related texts • Hair in Funny Places, (Babette Cole) • Giant, (Kate Scott) • You're Only Old Once! (Dr. Seuss) **Maths** • Investigate the weight of a human embryo during the different stages of development. • Find the mean, mode and median height in the class. Find average reaction times for an individual or group. **Geography** • Investigate how life expectancy varies around the world and why this is. **History** • Average life expectancy in the UK has increased dramatically since the beginning of the Victorian era. Investigate how and why life expectancy has changed in the UK. **Art** • Explore how humans age and change through the self-portraits of Rembrandt and other artists.

Unit and Vocabulary	Intent - statutory and non-statutory *(in italics)* content – Substantive (knowledge)	Intent –statutory and relevant non-statutory *(in italics)* content-Disciplinary (skills)
Properties and changes of materials everyday materials, wood, paper, plastic, metal, glass, water, rock, brick, stone, fabric, material, foil, elastic, dough, rubber, card, cardboard, clay, object, make/made, hard/soft, shiny/dull, stretchy/stiff, rough/smooth, bendy/not bendy, waterproof/not waterproof, transparent/opaque, absorbent/not absorbent, squash, twist, bend, stretch **<u>New Vocabulary</u>** **Properties, hardness, solubility, transparency, magnetism, solution, substance, separating, mixing, filtering, sieving** **reversible change, burning** **rusting, reactions, irreversible change, thermal/electrical insulator/conductor, change of state, mixture, dissolve, solution, soluble, insoluble, filter, sieve, reversible/non-reversible change, new material**	**Pupils should be taught to:** • compare and group together everyday materials based on their properties, including their hardness, solubility, transparency, conductivity (electrical and thermal), and response to magnets. • know that some materials will dissolve in liquid to form a solution and describe how to recover a substance from a solution. • use knowledge of solids, liquids, and gases to decide how mixtures might be separated, including through filtering, sieving, and evaporating. • give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials, including metals, wood and plastic. • demonstrate that dissolving, mixing and changes of state are reversible changes. • explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda. • *Pupils should build a more systematic understanding of materials by exploring and comparing the properties of a broad range of materials, including relating these to what they learnt about magnetism in year 3 and about electricity in year 4.* • *They should explore reversible changes, including, evaporating, filtering, sieving, melting and dissolving, recognising that melting and dissolving are different processes.*	**Pupils should be taught to:** • plan different types of scientific enquiries to answer their own questions, including recognising and controlling variables where necessary. • use test results to make predictions to set up further comparative and fair tests. • use a range of scientific equipment to take accurate and precise measurements or readings, with repeat readings where appropriate. • record data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar, and line graphs. • report and present findings from enquiries, including conclusions and causal relationships, in oral and written forms such as displays and other presentations, using appropriate scientific language. • explain degree of trust in results. • draw conclusions, explain, and evaluate their methods and findings, communicating these in a variety of ways.

	• *Pupils should explore changes that are difficult to reverse, for example, burning, rusting and other reactions, for example, vinegar with bicarbonate of soda.* • *They should find out about how chemists create new materials, for example, Spencer Silver, who invented the glue for sticky notes or Ruth Benerito, who invented wrinkle-free cotton.*	

Implementation-activity examples and cultural capital opportunities	**Observing over time** • Investigate what happens to saltwater when left to evaporate. Explore this as a means of separating a dissolved solid from a liquid. • Observe what happens to a soluble solid when placed in a liquid. • Observe the process of rusting by putting nails into water. Alternatively place a small amount of wire wool into vinegar for 2 minutes. Then expose to the air for 20 mins and observe what happens – it will rapidly rust. Key questions • **How does a container of saltwater change over time?** • **How does a sugar cube change as it is put in a glass of water?** • **How does a nail in saltwater change over time?** • **What happens to wire wool once it has been soaked in vinegar and then exposed to the air?** **Pattern Seeking** • Fair tests into dissolving rates (see below) will provide opportunities to identify patterns in data. • Investigate the stretchiness of different rubber bands by hanging weights on them and measuring how far they stretch. Key questions • **Does the width/thickness of a rubber band affect how stretchy it is?** • **Do all stretchy materials stretch in the same way?** • **How does temperature affect how much solute we can dissolve?** **Identifying and Classifying** • Provide a range of materials to be sorted based on their properties. Key questions • **How could you sort these materials into different groups?** • **Which of these materials are soluble, transparent, conductors/insulators (thermal/electrical)?** • **How could you find out which of these materials are soluble, transparent, conductors/insulators (thermal/electrical)?** **Comparative and Fair Testing** • Carry out fair tests to investigate the properties of different materials in order to recommend materials for particular functions depending on these properties e.g., test waterproofness and thermal insulation to identify a suitable fabric for a coat. • Collect sunglasses (of different cost). On a sunny day, place UV beads behind the lens of the sunglasses and see which are most effective at blocking UV light. Explore if more expensive sunglasses provide better protection than cheaper ones. UV beads are inexpensive and can be purchased via the internet. • Carry out fair tests to investigate what effects the rate that sugar/salt dissolves at e.g., temperature of the liquid or number of stirs. • Carry out comparative and fair tests involving non-reversible changes e.g.

	○ putting nails into different types of water (tap, salt, mineral), liquid (cooking oil, milk, coke etc) or water containing different amounts of salt. ○ Changing the amount of sugar/yeast or water temperature. • Pupils could make filters and vary their contents to see what effect this has on the water that passes through them e.g. for one filter they could have a layer of cotton wool or gravel. Key questions • **Which materials should we use to make a coat? Why?** • **How does the temperature of tea/water affect how long it takes for a sugar cube to dissolve?** • **Which type of sugar dissolves the fastest?** • **What affects the rate of rusting?** • **When experimenting with sugar/yeast how does varying the temperature of the water or amount of sugar/yeast affect the amount of gas produced?** • **Which pair of sunglasses blocks the most UV light?** • **Which filter is most effective at cleaning the water? Why might this be?** **Researching using secondary sources** • Research new materials produced by chemists e.g., Spencer Silver (glue of sticky notes) and Ruth Benerito (wrinkle free cotton). • Research the impact that plastics are having on the world. Key question • **What are microplastics and why are they harming the planet?** **Exploring and Problem Solving** • Challenge pupils to design and make their own filters using empty plastic two litre bottles (that have been cut in half) and natural materials that they've collected in the school grounds. • Explore reversible changes by observing the process of melting and freezing in the context of ice-cubes, chocolate, ice-cream or butter. • Explore how mixtures (where a chemical reaction hasn't take place) are reversible e.g. a mixture of water, stones, salt can be separated and returned to its constituent parts which haven't changed. • Explore ways that the process of dissolving could be represented using drawings or drama. • Explore adding a range of solids to water and other liquids e.g., cooking oil, as appropriate. • Investigate which materials are best for making a spacesuit and then design one. See Explorify for more information, https://explorify.uk/en/activities/problem-solvers/suits-you • Explore how to clean water using a molecular sieve. See the relevant PSTT I Bet You Didn't Know article, https://pstt.org.uk/resources/curriculum-materials/cutting-edge-science-primary-schools • Learn about the disastrous effects of historical ink. See the relevant PSTT I Bet You Didn't Know article, https://pstt.org.uk/resources/curriculum-materials/cutting-edge-science-primary-schools

	• Explore the science of hand washing. See the relevant PSTT I Bet You Didn't Know article, https://pstt.org.uk/resources/curriculum-materials/cutting-edge-science-primary-schools • Based on their learning, challenge pupils to think of new questions they'd like to investigate about the properties and changes of materials – where possible enable them to do investigations to answer them. Key questions • **How can we represent the process of dissolving?** • **What materials should a spacesuit be made from and why?** **Cultural capital opportunities** **Sustainable Development Goals**: 6 Clean water & Sanitation, 9 Industry, innovation & infrastructure, 11 Sustainable cities & communities. **Climate change links:** Concrete and steel are both the products of irreversible changes. The manufacture of these materials produces large amounts of greenhouse gases. Pupils could learn about the need to reduce our use of these materials and develop more environmentally friendly ways of making them. **Visits/trips**: Factories where materials are being made. A local science centre. **Visitors:** A chemist or materials scientist. See STEM Ambassadors, https://www.stem.org.uk/stem-ambassadors **Scientists:** Spencer Silver, Arthur Fry and Alan Amron (Post-It Notes) Ruth Benerito (Wrinkle-Free Cotton) **Enrichment experiences:** • Make concrete or bake bread/cakes/biscuits to explore other types of irreversible change. • Make a solar still, https://www.wikihow.com/Build-a-Still • Learn about new cutting-edge materials like Animate materials, https://royalsociety.org/topics-policy/projects/animate-materials/ • Begin to learn about and explore the Periodic Table. Pupils could learn about a different elements – tell pupils not to touch any dangerous chemicals and to only search for elements with a responsible adult. The Royal Society of Chemistry has an interactive Periodic Table, https://www.rsc.org/periodic-table/
Subject Links	**English** • Write consumer reports about products that pupils have evaluated using fair and comparative tests. Related texts • Itch, (Simon Mayo) • Kensuke's Kingdom, (Michael Morpurgo) • The BFG, (Roald Dahl) • Stick Dog Dreams of Ice Cream—Tom Watson ○ **Which material will be best to keep our ice cream solid?** **Maths** • Investigating dissolving rates (see Fair Test above) will provide opportunities for pupils to present data in line graphs, read scales (on thermometers) and use and apply their knowledge of time.

	DT • Use fair/comparative tests to evaluate the effectiveness of existing products e.g., which kitchen roll is most absorbent? Which gloves keep our hands warmest? **Geography** • Explore where materials that we use come from (both within the UK and globally). • Learn about salt pans and how salt is produced in hot parts of the world. • Learn about the impact of plastic pollution on the World's oceans. **History** • Learn about the role that early Arabic scientists played in our understanding of chemical processes like dissolving and irreversible changes. See 1001 Inventions for more information, https://www.1001inventions.com/ especially, https://www.1001inventions.com/initiatives/alchemy-to-chemistry/ • Learn about the development of a material like plastic or steel. **PE** • To model the process of dissolving, some pupils could be particles in a soluble solid while others are particles in a liquid. The 'solid' particles spread out among the 'liquid' particles

Unit and Vocabulary	Intent - statutory and non-statutory *(in italics)* content – Substantive (knowledge)	Intent –statutory and relevant non-statutory *(in italics)* content-Disciplinary (skills)
Earth and Space Seasons, seasonal change, spring, summer, autumn, winter, weather, sun, sunshine, rain, snow, sleet, ice, frost, fog, cloud, hot, cold, storm, sky, earth, night, day **<u>New vocabulary</u>** **Earth, Sun, Moon, (Mercury, Jupiter, Saturn, Venus, Mars, Uranus, Neptune), spherical, solar system, rotates, rotation, star, orbit, planets, satellite**	**Pupils should be taught to:** • describe the movement of the Earth, and other planets, relative to the Sun in the solar system. • describe the movement of the Moon relative to the Earth. • describe the Sun, Earth, and Moon as approximately spherical bodies. • use the idea of the Earth's rotation to explain day and night and the apparent movement of the Sun across the sky. • *Pupils should be introduced to a model of the Sun and Earth that enables them to explain day and night.* • *Pupils should learn that the Sun is a star at the centre of our solar system and that it has eight planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune (Pluto was reclassified as a 'dwarf planet' in 2006).* • *They should understand that a moon is a celestial body that orbits a planet (Earth has one moon; Jupiter has four large moons and numerous smaller ones).* • ***Note: Pupils should be warned that it is not safe to look directly at the Sun, even when wearing dark glasses.*** • *Pupils should find out about the way that ideas about the solar system have developed, understanding how the geocentric model of the solar system gave way to the heliocentric model by considering the work of scientists such as Ptolemy, Alhazen and Copernicus.*	**Pupils should be taught to:** • report and present findings from enquiries, including conclusions and causal relationships, in oral and written forms such as displays and other presentations, using appropriate scientific language. • draw conclusions, explain, and evaluate their methods and findings, communicating these in a variety of ways. • identify and evaluate scientific evidence (their own and others') that has been used to support or refute ideas or arguments. • describe and evaluate their own and others' scientific ideas related to topics in the national curriculum (including ideas that have changed over time), using evidence from a range of sources.

Implementation-activity examples and cultural capital opportunities	**Observing over time** • Keep a 'Moon diary' over the course of a month, sketching/photographing the Moon whenever possible. • Make first-hand observations of how shadows caused by the Sun change through the day and relate this to the rotation of the Earth. Key questions • **Can you observe and identify all the phases in the cycle of the Moon?** • **How does your shadow change over the course of a day?** **Pattern Seeking** • Provide pupils with data relating to the planets in the solar system (e.g. size, distance from the Sun, average surface temperature) and challenge them to identify patterns. Information about the average surface temperature of the planets can be found at, https://solarsystem.nasa.gov/resources/681/solar-system-temperatures/ Key questions • **Is there a pattern between the distance a planet is from the Sun and the length of its orbit?** • **Is there a pattern between the size of a planet and the time it takes to travel around the Sun?** • **Is there a pattern between the distance a planet is from the Sun and its average surface temperature?** **Identifying and Classifying** • Sort pictures of different objects in the solar system into groups using Venn, Carrol or branching databases. Key question • **How could you organise all the objects in the solar system into groups?** **Comparative and Fair Testing** • Fill a tray with flour. Sprinkle some cocoa powder on top. Investigate dropping balls into the tray to make craters. The height, size or angle could be changed. Key questions • **What effect does dropping the ball from different heights have on the width/depth of the crater?** • **What effect does dropping different sized balls have on the width/depth of the crater?** **Researching using secondary sources** • Research how our knowledge and understanding of the solar system has changed over time. Key question • **How have our ideas about the solar system changed over time?**

Exploring and Problem Solving

- Develop ways of demonstrating the movement of the Moon, Earth and Sun in relation to each other including the use of role play/drama and models e.g. different sized balls could be used to represent the Earth, Moon and Sun.
- Use secondary sources to help make a model to show why day and night occur.
- Explore the question, *who should own space?* See Explorify for more information, https://explorify.uk/en/activities/the-big-question/who-should-own-space
- Explore the question, *how many stars can we see?* See Explorify for more information, https://explorify.uk/en/activities/the-big-question/how-many-stars-can-we-see
- Explore the weather on Neptune. See 'There is a storm coming and it is not going away' article on the PSTT I Bet You Didn't Know resource, https://pstt.org.uk/resources/curriculum-materials/cutting-edge-science-primary-schools
- Based on their learning, challenge pupils to think of new questions they'd like to investigate about Earth and Space – where possible enable them to do investigations to answer them.

Cultural capital opportunities

Sustainable Development Goals: 9 Industry, innovation and infrastructure
Climate change links: Pupils could debate whether we should be trying to live on new planets like Mars rather than safeguarding the future of planet Earth.
Visits/trips: A local planetarium/science centre.
Visitors: A mobile planetarium. An amateur astronomer. An astrophysicist. See STEM Ambassadors, https://www.stem.org.uk/stem-ambassadors

Scientists

- Claudius Ptolemy and Nicolaus Copernicus (Heliocentric vs Geocentric Universe)
- Yuri Gagarin (First human in space)
- Neil Armstrong (First man on the Moon)
- Valentina Tereshkova (First woman into space)
- Mae Jemison (First black woman in space)
- Maggie Aderin Pocock (Astronomer and science communicator, co-host of CBeebies Stargazing & The Sky at Night)
- Helen Sharman (First British astronaut)
- Tim Peake (First British ESA astronaut)
- Katherine Johnson, Mary Jackson, Dorothy Vaughan (NASA mathematicians featured in the book and film, Hidden Figures)
- Jocelyn Bell, (Astro-physicist who discovered pulsars)

	Enrichment experiences • Hold a stargazing evening at your school. See The Ogden Trust for guidance, https://www.ogdentrust.com/resources/how-to-run-stargazing-events-for-pupils-and-parents Arrange to observe the Sun using solar telescopes. *This must only be carried out by experienced astronomers using the appropriate equipment. Always seek health and safety guidance from CLEAPSS, for more information see http://science.cleapss.org.uk/Resource-Info/PS017-Viewing-the-Sun.aspx .

Subject Links	**English**
	• Write a newspaper article about a significant event in space exploration.
	• Write a diary entry in the character of a famous astronaut or space scientist.
	
	Related texts
	• The Skies Above My Eyes,
	• (Charlotte Guillain & Yuval Zommer)
	• George's Secret Key to the Universe, (Lucy and Stephen Hawking with Christophe Galfard)
	• The Way Back Home, (Oliver Jeffers)
	• Look Up! (Nathan Bryon)
	• What Miss Mitchell Saw, (Hayley Barrett)
	• Caroline's Comets, (Emily Arnold McCully)
	• The Astronaut with a Song for the Stars, (Julia Finley Mosca)
	• Interstellar Cinderella, (Deborah Underwood)
	• Margaret and the Moon, (Dean Robbins)
	• Always Looking Up (Laura Gehl)
	• The Girl who Named Pluto, (Alice B. McGinty)
	• Gutsy Girls go for Science: Astronauts (Alecia Klepeis)
	• A Galaxy of her Own (Libby Jackson)
	• The Darkest Dark (Chris Hadfield)
	• Hidden Figures—Margot Shetterly
	  ○ **How many people does it take to get one person to the Moon?**
	  ○ **What jobs are involved in space exploration?**
	• Curiosity, the Story of a Mars Rover—Markus Motum
	  ○ **Can we design a shock-absorbing system that will allow a Mars Rover to land undamaged on the surface of Mars?**

Maths

- Pupils calculate what their age would be on different planets. See the National Schools Observatory for support with this, https://www.schoolsobservatory.org/discover/quick/planet_age
- Pupils calculate what their weight would be on different planets. See the National Schools Observatory for support with this, https://www.schoolsobservatory.org/discover/quick/weight.
- Pupils use their problem solving and measuring skills to make models to represent how the weight of something changes depending on the amount of gravity. See The Ogden Trust, Planetary Picnic activity, https://www.ogdentrust.com/resources/phizzi-practical-planetary-picnic
- Explore negative numbers in the context of the surface temperatures of planets. See https://solarsystem.nasa.gov/resources/681/solar-system-temperatures/
- Create scale models of the planets/solar system. See https://nrich.maths.org/7753
- Look at pictures of the different phases of the Moon and estimate what percentage/fraction of it's surface is illuminated/not illuminated.
- This topic provides the opportunity to discuss place value in relation to very large numbers in the context of:
    - Planetary distances from the Sun
    - The Moon's distance from the Earth
    - The distance of stars from the Earth

DT

- Make simple orreries to show the movement of the Earth, Moon and Sun.
- Make models to show the relative sizes/positions of the different planets.

PSHE

- Pupils could discuss the ethics/morality of space travel.
    - **Is it right to spend large sums of money on space exploration while so many people live in poverty on Earth?**
    - **Is it right to colonise another planet like Mars before we have solved the climate crisis on Earth?**
    - **Most space exploration can be carried out by probes/robots. Is it right to send humans into space when spaceflight is still potentially dangerous?**
    - **Is/was it right to send animals into space?**

Geography

- Learn about the geography or the Moon/Mars. Identify similarities and differences with the Earth.

	History
	• Learn how our knowledge and understanding of Space/the Solar System has changed over time. See Ogden Trust for supporting resources:
	  ○ https://www.ogdentrust.com/resources/scientific-ideas-over-time-history-of-the-universe
	  ○ https://www.ogdentrust.com/resources/timeline-card-sort-game-moon-landings
	  ○ https://www.ogdentrust.com/resources/research-cards-earth-and-space
	• Research the history of Moon exploration, https://www.ogdentrust.com/resources/research-cards-moon-landings
	
	Music/Art
	• Learn about the music and art that was recorded on the golden disk which is on the Voyager 1 space probe. See https://voyager.jpl.nasa.gov/golden-record/
	• Learn about Gustav's Holst's The Planet Suite.
	
	PE
	• Use the Mission X 'train like and astronaut' resources during PE lessons, https://www.stem.org.uk/missionx
	• Learn about the exercise regime of astronauts on the International Space Station.
	• Learn about the effects that being in Space has on the human body.

Unit and Vocabulary	Intent - statutory and non-statutory *(in italics)* content – Substantive (knowledge)	Intent –statutory and relevant non-statutory *(in italics)* content-Disciplinary (skills)
Forces Move, movement, surfaces, forces, push, pull, contact, distance, magnet, bar magnet ring magnet, horseshoe, magnet, attract, repel, poles (of magnets), magnetic materials **<u>New Vocabulary</u>** **Force, gravity, Earth, air resistance, water resistance, friction, mechanisms, simple machines, levers, pulleys, gears**	**Pupils should be taught to:** • explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object. • identify the effects of air resistance, water resistance and friction that act between moving surfaces. • recognise that some mechanisms, including levers, pulleys, and gears, allow a smaller force to have a greater effect.	**Pupils should be taught to:** • plan different types of scientific enquiries to answer their own questions, including recognising and controlling variables where necessary. • use test results to make predictions to set up further comparative and fair tests. • use a range of scientific equipment to take accurate and precise measurements or readings, with repeat readings where appropriate. • record data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar, and line graphs. • report and present findings from enquiries, including conclusions and causal relationships, in oral and written forms such as displays and other presentations, using appropriate scientific language. • explain degree of trust in results. • draw conclusions, explain, and evaluate their methods and findings, communicating these in a variety of ways.

Implementation-activity examples and cultural capital opportunities	**Observing over time** • Observe how long it takes different pendulums to stop swinging. Key question • **How long does a pendulum swing for before it stops?** **Pattern Seeking** • Identify patterns in the data from the comparative/fair tests (see below). Key questions • **Do all objects fall through water in the same way?** • **How does the surface area of an object affect how it falls through water?** • **How does the surface area of a parachute affect the time it takes to fall?** **Identifying and Classifying** • Identify the forces acting in photographs of different scenarios e.g., a child on a swing, someone parachuting out of an aeroplane. • Identify areas of high and low friction around the school/school grounds. This can be done by dragging a weighted container (like an empty margarine tub) over a surface with a forcemeter. Pupils could design posters to warn about slip hazards and produce friction maps of the school. Key questions • **Can you label and name all the forces acting on the objects in each of these situations?** • **Which areas of the school/school grounds have high/low friction?** **Comparative and Fair Testing** • Carry out comparative/fair tests to investigate the effects of water resistance in a range of contexts e.g., dropping shapes (made out of plasticine or modelling clay) through water and pulling shapes, such as boats, along the surface of water. • Carry out comparative/fair tests into air resistance e.g., making parachutes/paper helicopters with different sized canopies/rotor blades and seeing what effect this has on the speed of descent. • Carry out comparative tests to investigate the effect that pulleys have on the force required to lift an object. Start by lifting an object with a force meter. Then add a pulley and repeat. Continue to add pulleys and record the amount of force required. For information about how to make and investigate simple pulleys go to, https://nustem.uk/activity/levers-pulleys-and-gears-key-stages-1-2/ • Make simple catapults using lollipops sticks and rubber bands and simple 'mangonels' using cups, spoons and rubber bands to learn about levers. For guidance about how to do this go to, https://nustem.uk/activity/levers-pulleys-and-gears-key-stages-1-2/ • For information about activities related to gears go to, https://nustem.uk/activity/levers-pulleys-and-gears-key-stages-1-2/ • Investigate how much 'grip' different types of shoes have. See The Ogden Trust for more information, https://www.ogdentrust.com/resources/phizzi-enquiry-slippy-shoes

Key questions

- **How does the angle of launch affect how far a paper rocket will go?**
- **How does the surface area of an object affect the time it takes to sink?**
- **How does the size of a parachute's canopy/paper helicopters rotor blades effect how long it takes to fall to the ground?**
- **Which shoe is the most slippy?**
- **Which shape parachute takes the longest to fall?**

Researching using secondary sources

- Research how a submarine is able to sink and float.
- Research how our ideas of friction and gravity have changed over time. See The Ogden Trust for more information, https://www.ogdentrust.com/resources/research-cards-friction and https://www.ogdentrust.com/resources/research-cards-gravity

Key question

- **How do submarines sink if they are full of air?**

Exploring and Problem Solving

- Explore playground equipment and identify which areas are designed to have high and low friction e.g. steps are rough, a slide is smooth etc.
    - Pupils could design their own playground equipment and identify where there will be high/low friction and why.
- Pupils could explore forces in the context of rollercoasters and design their own rollercoaster.
- Learners could draw arrows onto a picture of Earth to show the direction gravity pulls in.
- Explore the effect of friction in a range of contexts e.g., trainers, bathmats, mats for a helter-skelter.
- Make a product that involves a lever, pulley, or gear.
- Create a timer that uses gravity to move a ball.
- Investigate which design of paper airplane flies the furthest. See Explorify for more information, https://explorify.uk/en/activities/problem-solvers/paper-planes
- Use the Colorado Phet simulations to explore forces, https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html&sort=alpha&view=grid
- Based on their learning, challenge pupils to think of new questions they'd like to investigate about forces – where possible enable them to do investigations to answer them.

Key questions

- **How can we create a timer that uses gravity?**
- **Which paper airplane flies the furthest?**

	Cultural capital opportunities **Climate change links:** Explore how more aerodynamic designs can make cars/lorries/aeroplanes more fuel efficient and reduce harmful pollution/gas emissions. **Visits/trips**: A local science centre. A factory making cars/aeroplanes/ships. **Visitors:** A physicist, an automotive/aeronautical/nautical engineer/designer. See STEM Ambassadors, https://www.stem.org.uk/stem-ambassadors **Scientists:** Galileo Galilei (Gravity and Acceleration), Isaac Newton (Gravitation), Archimedes of Syracuse (Levers), John Walker (The Match) **Enrichment experiences:** • Explore gravity and air resistance by making and launching 'film canister' or 'bottle' rockets. • Use the simulator on the National Schools Observatory website to explore gravity, https://www.schoolsobservatory.org/discover/sims-cals/gravsim • Use the simulator on the National Schools Observatory to explore how the Sun and Moon's gravitational pull cause tides on the Earth, https://www.schoolsobservatory.org/discover/sims-cals/tidesim
Subject Links	**English** • Write a short science fiction story based on the premise, 'what if friction/gravity stopped?' Related texts ○ The Enormous Turnip, (Katie Daynes) ○ Leonardo's Dream, (Hans de Beer) ○ The Aerodynamics of Biscuits, (Clare Helen Welsh) ○ The Lighthouse Keeper's Lunch — Ronda & David Armitage **Maths** • When investigating air resistance pupils could find the area of the different sized parachutes/sails (on a model boat) that they are experimenting with. • Present data from investigations into air/water resistance in bar and line graphs. • Investigate changing the angle that a paper rocket or canon is launched at and what impact this has on how far it travels. For more information on 'paper canons' see, https://www.rigb.org/families/experimental/rubber-band-cannons • When launching film canister or bottle rockets increase the amount of water by a specific fraction or percentage. • See Earth and Space above for 'gravity maths' activities. **Computing/Technology** • Use the Colorado Phet simulations to explore forces, https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html&sort=alpha&view=grid

	DT • Make parachutes, model boats and rockets to investigate gravity and air/water resistance. • Use fair/comparative tests to evaluate the effectiveness of existing products e.g., which trainer has the most grip? • Make a product that involves a lever, pulley, or gear. • Create a timer that uses gravity to move a ball. **History** • Learn about how our ideas of friction and gravity have changed over time. See The Ogden Trust for more information, https://www.ogdentrust.com/resources/research-cards-friction and https://www.ogdentrust.com/resources/research-cards-gravity **PE** • During PE lessons pupils can experience and explore a range of forces e.g. air resistance and friction while running.

Criteria to assess readiness for next year group	**Working scientifically (these criteria are to be achieved by the end of UKS2)** The pupil can, using appropriate scientific language from the national curriculum: • describe and evaluate their own and others' scientific ideas related to topics in the national curriculum (including ideas that have changed over time), using evidence from a range of sources • ask their own questions about the scientific phenomena that they are studying, and select the most appropriate ways to answer these questions, recognising and controlling variables where necessary (i.e., observing changes over different periods of time, noticing patterns, grouping, and classifying things, carrying out comparative and fair tests, and finding things out using a wide range of secondary sources) • use a range of scientific equipment to take accurate and precise measurements or readings, with repeat readings where appropriate • record data and results using scientific diagrams and labels, classification keys, tables, scatter graphs, bar, and line graphs • draw conclusions, explain, and evaluate their methods and findings, communicating these in a variety of ways • raise further questions that could be investigated, based on their data and observations. **Science content** The pupil can: • describe and compare different reproductive processes and life cycles in animals [year 5] • group and identify materials [year 5], in different ways according to their properties, based on first-hand observation; and justify the use of different everyday materials for different uses, based on their properties [year 5] • identify and describe what happens when dissolving occurs in everyday situations; and describe how to separate mixtures and solutions into their components [year 5] • identify, with reasons, whether changes in materials are reversible or not [year 5] • describe the effects of simple forces that involve contact (air and water resistance, friction) [year 5] and gravity [year 5] • identify simple mechanisms, including levers, gears and pulleys, that increase the effect of a force [year 5] • describe the shapes and relative movements of the Sun, Moon, Earth and other planets in the solar system; and explain the apparent movement of the sun across the sky in terms of the Earth's rotation and that this results in day and night [year 5].

Implementation-activity examples and cultural capital opportunities	**Observing over time** • Grow and observe plants that reproduce asexually e.g., strawberries, spider plants, potatoes. • Plant bulbs and then harvest to see how they multiply. • Make first-hand observations of the life-cycles of a range of animals e.g. chickens, butterflies, snails, frogs, brine shrimps* Key questions • **How do potato plants grow and reproduce?** • **Where there any changes when we harvested our bulbs?** • **How do chickens/butterflies/snails change and develop?** **Pattern Seeking** • Compare the gestation times for mammals and look for patterns e.g., in relation to size of animal or length of dependency after birth. • Look for patterns between the size of an animal and its expected life span. Key questions • **Is there a relationship between the size of a mammal and its gestation period?** • **Is there a relationship between the size of a mammal and how long its young are dependent after birth?** **Identifying and Classifying** • Compare this collection of animals based on similarities and differences in their lifecycle. Key questions • **What are the similarities and differences in the lifecycles of these animals?** • **How could you sort these animals based on their lifecycles?** **Comparative and Fair Testing** • Change the conditions that brine shrimp eggs are in (e.g., the amount of salt) and observe the impact this has on hatching time. Key question • **How does the level of salt affect how quickly brine shrimp hatch?** **Researching using secondary sources** • Use secondary sources to find out about pollination. • Research the differences between the lifecycle of an insect/mammal, bird/fish etc. Key questions • **What are the differences between the life cycle of an insect and a mammal?** • **What is the process of pollination?**

	Exploring and Problem Solving • Explore unusual lifecycles e.g., Marsupials, Seahorses or egg laying mammals like Platypuses/Echidnas. • Explore the lifecycles of a range of mammals, insects, fish and birds. • Explore ways of presenting different lifecycles including using drawings, drama and making models. • Explore ways of presenting the process of pollination including using drawings, drama and making models. • Explore the question, *which pollinators visit our school grounds?* See Explorify for more information, https://explorify.uk/en/activities/the-big-question/which-pollinators-visit-our-school-grounds • Based on their learning, challenge pupils to think of new questions they'd like to investigate about living things and their habitats – where possible enable them to do investigations to answer them. Key questions • **What is the lifecycle of a platypus? How is this different to other mammals?** • **What are the similarities/differences between the lifecycles of a horse and an elephant? A blue tit and a Golden Eagle?** **Cultural capital opportunities** **Sustainable Development Goals**: 13 Climate Action, 14 Life below land, 15 Life on land **Climate change links:** Learn about the impact that climate change is having on the lifecycle of animals and plants. Explore how the early onset of spring negatively impacts on the life cycle of animals and plants. **Visits/trips**: A local zoo or wildlife centre. A botanic garden or garden centre/nursery. An arable farm **Visitors:** A biologist, zoologist, or vet. A gardener/farmer. See Encounter Edu, https://encounteredu.com/. See Farmer Time https://leaf.eco/farmertime/home **Scientists:** James Brodie of Brodie (Reproduction of Plants by Spores) David Attenborough (Naturalist and Nature Documentary Broadcaster) ***Make sure pupils are exposed to a diverse range of scientists including scientists who are working today. See,** • **The PSTT** https://pstt.org.uk/resources/curriculum-materials/ASJLM **&** https://pstt.org.uk/resources/curriculum-materials/Science-at-Work • **The Ogden Trust** https://www.ogdentrust.com/resources/research-cards-women-in-physics • **STEM Sisters** http://www.hmdt.org.uk/hmdtmusic/stemsisters/the-stem-sisters-2/ • **Oxford Sparks** https://www.oxfordsparks.ox.ac.uk/justaddimagination **for resources to support this.** **Enrichment experiences:** • Pupils could rear animals from young to adulthood e.g., chicks. • Pupils could keep tadpoles or caterpillars and observe their lifecycle. • Pupils could keep native species of snail and observe their lifecycle from egg to fully grown snail.

Subject Links	

English

- Pupils write their own version of 'The Tadpole's Promise by Jeanne Willis.
- Pupils write a story based on the life cycle of an animal inspired by stories like 'The Very Hungry Caterpillar' by Eric Carle or 'The Tadpoles Promise'.

Related texts

- The Land of Neverbelieve, (Norman Messenger)
- Mummy Laid an Egg, (Babette Cole)
- Tadpole's Promise—Jeanne Willis & Tony Ross
  - **What are the similarities and differences in the life cycles of a frog and a butterfly?**
  - **What other insects go through metamorphosis?**
- Cicada—Shaun Tan
  - **How is a real cicada's life cycle similar/different to the one in the story?**
- The Boy in the Tower—Polly Ho-Yen
  - **How do different plants reproduce?**
  - **Which plants reproduce using spores?**

Maths

- Measure and compare the growth rates of different plants.
- Measure the increase of mass in potatoes when they are harvested.
- Convert gestation times for different animals into hours/seconds.

Computing/Technology

- Present information about life cycles using PowerPoint or Google Slides.
- Make simple stop-frame animations to show the life cycles of animals.

DT

- Make models to show the life cycles of animals.

Geography

- Learn about where different animals are found in the UK/ world.

Unit and Vocabulary	Intent - statutory and non-statutory *(in italics)* content – Substantive (knowledge)	Intent –statutory and relevant non-statutory *(in italics)* content-Disciplinary (skills)
Animals including humans names of common animals: fish, amphibians, reptiles, birds, mammals, carnivores, herbivores, omnivores, human, body, senses, see, hear, feel, smell, taste, habitat, local environment, pet, wild animal, insect, minibeast, food, eat, head, neck, body, arms, legs, ears, eyes, nose, mouth, tongue, hands, feet, fingers, toes, elbows, knees, hair, teeth grow, healthy, offspring, adults, young, water, air, survive, exercise, hygiene, egg, chick, chicken, caterpillar, pupa, moth, butterfly, tadpole, frog, frog spawn, lamb, sheep, calf, cow, foal, horse, nutrition, diet, skeleton, muscles, protection, support, movement, bones skull, shell, digestive system, stomach, small intestine, large intestine, oesophagus types of teeth: molar, premolar, incisor, canine saliva **New Vocabulary** **Puberty, gestation period, embryo**	**Pupils should be taught to:** • describe the changes as humans develop to old age. • *Pupils should draw a timeline to indicate stages in the growth and development of humans. They should learn about the changes experienced in puberty.*	**Pupils should be taught to:** • report and present findings from enquiries, including conclusions and causal relationships, in oral and written forms such as displays and other presentations, using appropriate scientific language.
Implementation-activity examples and cultural capital opportunities	**Observing over time** • Look at pictures of different animal's embryos and observe how they change over time. Key question • **How do different animal embryos change?**	

	Pattern Seeking • Measure the height of everyone in the class and identify any patterns. • Measure pupils from different year groups and identify any patterns. • Measure the handspans of pupils in the class. Key questions • **Are the oldest pupils in our class/school the tallest?** • **Does the tallest person had the widest handspan?** **Identifying and Classifying** • Use photographs to identify the different stages of the human life cycle. Key question • **Can you identify all the stages in the human life cycle?** **Comparative and Fair Testing** • Test the reaction times of differently aged people including adults and identify any patterns in the data. Reaction times can be tested using a ruler. • Measure the height of everyone in the class. Re-measure regularly and compare growth rates between boys and girls. Key questions • **How does age affect a human's reaction time?** • **Who grows the fastest, girls or boys?** **Researching using secondary sources** • Research average life expectancy in different countries and how this has changed significantly in the last hundred years. • Research what happens to the human body as it ages. Key questions • **How has average life expectancy changed in the UK?** • **How does average life expectancy in the UK compare to other countries?** • **Why do people get grey/white hair when they get older?** **Exploring and Problem Solving** • Explore the impacts that an aging society will have and how we can stay fit and healthy into old age. See Explorify, https://explorify.uk/en/activities/the-big-question/how-can-we-stay-fit-and-healthy-as-we-get-older • Through a whole class discussion explore, 'what if the average life-span of a human was 200?' See Explorify, https://explorify.uk/en/activities/what-if/the-average-lifespan-of-a-human-was-200 • Based on their learning, challenge pupils to think of new questions they'd like to investigate about humans – where possible enable them to do investigations to answer them. Key question • **How can we stay fit and healthy as we get older?**

	Cultural capital opportunities: **Sustainable Development Goals**: **Climate change links:** Learn about the impact that climate change might have on average human life expectancy. **Visits/trips**: A local day care centre for the elderly. **Visitors:** An elderly person. **Scientists:** Dr Steve Jones (Geneticist) Prof Robert Winston (Human Scientist)
Subject Links	**English** • Write a short science fiction based on the premise, *'what if everyone stopped aging?'* Related texts • Hair in Funny Places, (Babette Cole) • Giant, (Kate Scott) • You're Only Old Once! (Dr. Seuss) **Maths** • Investigate the weight of a human embryo during the different stages of development. • Find the mean, mode and median height in the class. • Find average reaction times for an individual or group. **Geography** • Investigate how life expectancy varies around the world and why this is. **History** • Average life expectancy in the UK has increased dramatically since the beginning of the Victorian era. Investigate how and why life expectancy has changed in the UK. **Art** • Explore how humans age and change through the self-portraits of Rembrandt and other artists.

Unit and Vocabulary	Intent - statutory and non-statutory *(in italics)* content – Substantive (knowledge)	Intent –statutory and relevant non-statutory *(in italics)* content-Disciplinary (skills)
Properties and changes of materials everyday materials, wood, paper, plastic, metal, glass, water, rock, brick, stone, fabric, material, foil, elastic, dough, rubber, card, cardboard, clay, object, make/made, hard/soft, shiny/dull, stretchy/stiff, rough/smooth, bendy/not bendy, waterproof/not waterproof, transparent/opaque, absorbent/not absorbent, squash, twist, bend, stretch **<u>New Vocabulary</u>** **Properties, hardness, solubility, transparency, magnetism, solution, substance, separating, mixing, filtering, sieving** **reversible change, burning** **rusting, reactions, irreversible change, thermal/electrical insulator/conductor, change of state, mixture, dissolve, solution, soluble, insoluble, filter, sieve, reversible/non-reversible change, new material**	**Pupils should be taught to:** • compare and group together everyday materials based on their properties, including their hardness, solubility, transparency, conductivity (electrical and thermal), and response to magnets. • know that some materials will dissolve in liquid to form a solution and describe how to recover a substance from a solution. • use knowledge of solids, liquids, and gases to decide how mixtures might be separated, including through filtering, sieving, and evaporating. • give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials, including metals, wood and plastic. • demonstrate that dissolving, mixing and changes of state are reversible changes. • explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda. • *Pupils should build a more systematic understanding of materials by exploring and comparing the properties of a broad range of materials, including relating these to what they learnt about magnetism in year 3 and about electricity in year 4.* • *They should explore reversible changes, including, evaporating, filtering, sieving, melting and dissolving, recognising that melting and dissolving are different processes.*	**Pupils should be taught to:** • plan different types of scientific enquiries to answer their own questions, including recognising and controlling variables where necessary. • use test results to make predictions to set up further comparative and fair tests. • use a range of scientific equipment to take accurate and precise measurements or readings, with repeat readings where appropriate. • record data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar, and line graphs. • report and present findings from enquiries, including conclusions and causal relationships, in oral and written forms such as displays and other presentations, using appropriate scientific language. • explain degree of trust in results. • draw conclusions, explain, and evaluate their methods and findings, communicating these in a variety of ways.

	• *Pupils should explore changes that are difficult to reverse, for example, burning, rusting and other reactions, for example, vinegar with bicarbonate of soda.* • *They should find out about how chemists create new materials, for example, Spencer Silver, who invented the glue for sticky notes or Ruth Benerito, who invented wrinkle-free cotton.*	

Implementation-activity examples and cultural capital opportunities	**Observing over time**
	• Investigate what happens to saltwater when left to evaporate. Explore this as a means of separating a dissolved solid from a liquid.
	• Observe what happens to a soluble solid when placed in a liquid.
	• Observe the process of rusting by putting nails into water. Alternatively place a small amount of wire wool into vinegar for 2 minutes. Then expose to the air for 20 mins and observe what happens – it will rapidly rust.
	Key questions
	• **How does a container of saltwater change over time?**
	• **How does a sugar cube change as it is put in a glass of water?**
	• **How does a nail in saltwater change over time?**
	• **What happens to wire wool once it has been soaked in vinegar and then exposed to the air?**
	
	Pattern Seeking
	• Fair tests into dissolving rates (see below) will provide opportunities to identify patterns in data.
	• Investigate the stretchiness of different rubber bands by hanging weights on them and measuring how far they stretch.
	Key questions
	• **Does the width/thickness of a rubber band affect how stretchy it is?**
	• **Do all stretchy materials stretch in the same way?**
	• **How does temperature affect how much solute we can dissolve?**
	
	Identifying and Classifying
	• Provide a range of materials to be sorted based on their properties.
	Key questions
	• **How could you sort these materials into different groups?**
	• **Which of these materials are soluble, transparent, conductors/insulators (thermal/electrical)?**
	• **How could you find out which of these materials are soluble, transparent, conductors/insulators (thermal/electrical)?**
	
	Comparative and Fair Testing
	• Carry out fair tests to investigate the properties of different materials in order to recommend materials for particular functions depending on these properties e.g., test waterproofness and thermal insulation to identify a suitable fabric for a coat.
	• Carry out fair tests to investigate what effects the rate that sugar/salt dissolves at e.g., temperature of the liquid or number of stirs.
	• Carry out comparative and fair tests involving non-reversible changes e.g.
	  ○ putting nails into different types of water (tap, salt, mineral), liquid (cooking oil, milk, coke etc) or water containing different amounts of salt.
	  ○ Changing the amount of sugar/yeast or water temperature.

Key questions

- **Which materials should we use to make a coat? Why?**
- **How does the temperature of tea/water affect how long it takes for a sugar cube to dissolve?**
- **Which type of sugar dissolves the fastest?**
- **What affects the rate of rusting?**
- **What affects the amount of gas produced?**

Researching using secondary sources

- Research new materials produced by chemists e.g., Spencer Silver (glue of sticky notes) and Ruth Benerito (wrinkle free cotton).
- Research the impact that plastics are having on the world.

Key question

- **What are microplastics and why are they harming the planet?**

Exploring and Problem Solving

- Explore ways that the process of dissolving could be represented using drawings or drama.
- Explore adding a range of solids to water and other liquids e.g., cooking oil, as appropriate.
- Investigate which materials are best for making a spacesuit and then design one. See Explorify for more information, https://explorify.uk/en/activities/problem-solvers/suits-you
- Explore how to clean water using a molecular sieve. See the relevant PSTT I Bet You Didn't Know article, https://pstt.org.uk/resources/curriculum-materials/cutting-edge-science-primary-schools
- Learn about the disastrous effects of historical ink. See the relevant PSTT I Bet You Didn't Know article, https://pstt.org.uk/resources/curriculum-materials/cutting-edge-science-primary-schools
- Explore the science of hand washing. See the relevant PSTT I Bet You Didn't Know article, https://pstt.org.uk/resources/curriculum-materials/cutting-edge-science-primary-schools
- Based on their learning, challenge pupils to think of new questions they'd like to investigate about the properties and changes of materials – where possible enable them to do investigations to answer them.

Key questions

- **How can we represent the process of dissolving?**
- **What materials should a spacesuit be made from and why?**

Cultural capital opportunities:

Sustainable Development Goals: 6 Clean water & Sanitation, 9 Industry, innovation & infrastructure, 11 Sustainable cities & communities.

Climate change links: Concrete and steel are both the products of irreversible changes. The manufacture of these materials produces large amounts of greenhouse gases. Pupils could learn about the need to reduce our use of these materials and develop more environmentally friendly ways of making them.

Visits/trips: Factories where materials are being made. A local science centre.

Visitors: A chemist or materials scientist. See STEM Ambassadors, https://www.stem.org.uk/stem-ambassadors

	Scientists: Spencer Silver, Arthur Fry and Alan Amron (Post-It Notes) Ruth Benerito (Wrinkle-Free Cotton) **Enrichment experiences:** • Make concrete or bake bread/cakes/biscuits to explore other types of irreversible change. • Make a solar still, https://www.wikihow.com/Build-a-Still • Learn about new cutting-edge materials like Animate materials, https://royalsociety.org/topics-policy/projects/animate-materials/ • Begin to learn about and explore the Periodic Table. Pupils could learn about a different elements – tell pupils not to touch any dangerous chemicals and to only search for elements with a responsible adult. The Royal Society of Chemistry has an interactive Periodic Table, https://www.rsc.org/periodic-table/
Subject Links	**English** • Write consumer reports about products that pupils have evaluated using fair and comparative tests. Related texts • Itch, (Simon Mayo) • Kensuke's Kingdom, (Michael Morpurgo) • The BFG, (Roald Dahl) • Stick Dog Dreams of Ice Cream—Tom Watson o **Which material will be best to keep our ice cream solid?** **Maths** • Investigating dissolving rates (see Fair Test above) will provide opportunities for pupils to present data in line graphs, read scales (on thermometers) and use and apply their knowledge of time. **DT** • Use fair/comparative tests to evaluate the effectiveness of existing products e.g., which kitchen roll is most absorbent? Which gloves keep our hands warmest? **Geography** • Explore where materials that we use come from (both within the UK and globally). • Learn about salt pans and how salt is produced in hot parts of the world. • Learn about the impact of plastic pollution on the World's oceans. **History** • Learn about the role that early Arabic scientists played in our understanding of chemical processes like dissolving and irreversible changes. See 1001 Inventions for more information, https://www.1001inventions.com/ especially, https://www.1001inventions.com/initiatives/alchemy-to-chemistry/ • Learn about the development of a material like plastic or steel.

	PE • Some pupils could be particles in a soluble solid while others are particles in a liquid. The ‘solid’ particles spread among the ‘liquid’ particles.

Unit and Vocabulary	Intent - statutory and non-statutory *(in italics)* content – Substantive (knowledge)	Intent –statutory and relevant non-statutory *(in italics)* content-Disciplinary (skills)
Earth and Space Seasons, seasonal change, spring, summer, autumn, winter, weather, sun, sunshine, rain, snow, sleet, ice, frost, fog, cloud, hot, cold, storm, sky, earth, night, day **<u>New vocabulary</u>** **Earth, Sun, Moon, (Mercury, Jupiter, Saturn, Venus, Mars, Uranus, Neptune), spherical, solar system, rotates, rotation, star, orbit, planets, satellite**	**Pupils should be taught to:** • describe the movement of the Earth, and other planets, relative to the Sun in the solar system. • describe the movement of the Moon relative to the Earth. • describe the Sun, Earth, and Moon as approximately spherical bodies. • use the idea of the Earth's rotation to explain day and night and the apparent movement of the Sun across the sky. • *Pupils should be introduced to a model of the Sun and Earth that enables them to explain day and night.* • *Pupils should learn that the Sun is a star at the centre of our solar system and that it has eight planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune (Pluto was reclassified as a 'dwarf planet' in 2006).* • *They should understand that a moon is a celestial body that orbits a planet (Earth has one moon; Jupiter has four large moons and numerous smaller ones).* • ***Note: Pupils should be warned that it is not safe to look directly at the Sun, even when wearing dark glasses.*** • *Pupils should find out about the way that ideas about the solar system have developed, understanding how the geocentric model of the solar system gave way to the heliocentric model by considering the work of scientists such as Ptolemy, Alhazen and Copernicus.*	**Pupils should be taught to:** • report and present findings from enquiries, including conclusions and causal relationships, in oral and written forms such as displays and other presentations, using appropriate scientific language. • draw conclusions, explain, and evaluate their methods and findings, communicating these in a variety of ways. • identify and evaluate scientific evidence (their own and others') that has been used to support or refute ideas or arguments. • describe and evaluate their own and others' scientific ideas related to topics in the national curriculum (including ideas that have changed over time), using evidence from a range of sources.

Implementation-activity examples and cultural capital opportunities	**Observing over time** • Keep a 'Moon diary' over the course of a month, sketching/photographing the Moon whenever possible. • Make first-hand observations of how shadows caused by the Sun change through the day and relate this to the rotation of the Earth. Key questions • **Can you observe and identify all the phases in the cycle of the Moon?** • **How does your shadow change over the course of a day?** **Pattern Seeking** • Provide pupils with data relating to the planets in the solar system (e.g. size, distance from the Sun, average surface temperature) and challenge them to identify patterns. Information about the average surface temperature of the planets can be found at, https://solarsystem.nasa.gov/resources/681/solar-system-temperatures/ Key questions • **Is there a pattern between the distance a planet is from the Sun and the length of its orbit?** • **Is there a pattern between the size of a planet and the time it takes to travel around the Sun?** • **Is there a pattern between the distance a planet is from the Sun and its average surface temperature?** **Identifying and Classifying** • Sort pictures of different objects in the solar system into groups using Venn, Carrol or branching databases. Key question • **How could you organise all the objects in the solar system into groups?** **Comparative and Fair Testing** • Fill a tray with flour. Sprinkle some cocoa powder on top. Investigate dropping balls into the tray to make craters. The height, size or angle could be changed. Key questions • **What effect does dropping the ball from different heights have on the width/depth of the crater?** • **What effect does dropping different sized balls have on the width/depth of the crater?** **Researching using secondary sources** • Research how our knowledge and understanding of the solar system has changed over time. Key question • **How have our ideas about the solar system changed over time?**

	Exploring and Problem Solving • Develop ways of demonstrating the movement of the Moon, Earth and Sun in relation to each other including the use of role play/drama and models e.g. different sized balls could be used to represent the Earth, Moon and Sun. • Use secondary sources to help make a model to show why day and night occur. • Explore how sundials. • Make simple sundials • Explore the question, *who should own space?* See Explorify for more information, https://explorify.uk/en/activities/the-big-question/who-should-own-space • Explore the question, *how many stars can we see?* See Explorify for more information, https://explorify.uk/en/activities/the-big-question/how-many-stars-can-we-see • Explore the weather on Neptune. See 'There is a storm coming and it is not going away' article on the PSTT I Bet You Didn't Know resource, https://pstt.org.uk/resources/curriculum-materials/cutting-edge-science-primary-schools • Based on their learning, challenge pupils to think of new questions they'd like to investigate about Earth and Space – where possible enable them to do investigations to answer them. **Cultural capital opportunities** **Climate change links:** Pupils could debate whether we should be trying to live on new planets like Mars rather than safeguarding the future of planet Earth. **Visits/trips**: A local planetarium/science centre. **Visitors:** A mobile planetarium. An amateur astronomer. An astrophysicist. See STEM Ambassadors, https://www.stem.org.uk/stem-ambassadors **Scientists:** • Claudius Ptolemy and Nicolaus Copernicus (Heliocentric vs Geocentric Universe) • Yuri Gagarin (First human in space) • Neil Armstrong (First man on the Moon) • Valentina Tereshkova (First woman into space) • Mae Jemison (First black woman in space) • Maggie Aderin Pocock (Astronomer and science communicator, co-host of CBeebies Stargazing & The Sky at Night) • Helen Sharman (First British astronaut) • Tim Peake (First British ESA astronaut) • Katherine Johnson, Mary Jackson, Dorothy Vaughan (NASA mathematicians featured in the book and film, Hidden Figures) • Jocelyn Bell, (Astro-physicist who discovered pulsars) **Enrichment experiences:** • Hold a stargazing evening at your school. See The Ogden Trust for guidance, https://www.ogdentrust.com/resources/how-to-run-stargazing-events-for-pupils-and-parents • Arrange to observe the Sun using solar telescopes. *This must only be carried out by experienced astronomers.

Subject Links	**English**
	• Write a newspaper article about a significant event in space exploration.
	• Write a diary entry in the character of a famous astronaut or space scientist.
	
	Related texts
	• The Skies Above My Eyes,
	• (Charlotte Guillain & Yuval Zommer)
	• George's Secret Key to the Universe, (Lucy and Stephen Hawking with Christophe Galfard)
	• The Way Back Home, (Oliver Jeffers)
	• Look Up! (Nathan Bryon)
	• What Miss Mitchell Saw, (Hayley Barrett)
	• Caroline's Comets, (Emily Arnold McCully)
	• The Astronaut with a Song for the Stars, (Julia Finley Mosca)
	• Interstellar Cinderella, (Deborah Underwood)
	• Margaret and the Moon, (Dean Robbins)
	• Always Looking Up (Laura Gehl)
	• The Girl who Named Pluto, (Alice B. McGinty)
	• Gutsy Girls go for Science: Astronauts (Alecia Klepeis)
	• A Galaxy of her Own (Libby Jackson)
	• The Darkest Dark (Chris Hadfield)
	• Hidden Figures—Margot Shetterly
	  ○ **How many people does it take to get one person to the Moon?**
	  ○ **What jobs are involved in space exploration?**
	• Curiosity, the Story of a Mars Rover—Markus Motum
	  ○ **Can we design a shock-absorbing system that will allow a Mars Rover to land undamaged on the surface of Mars?**
	
	Maths
	• Pupils calculate what their age would be on different planets.
	• Pupils calculate what their weight would be on different planets.
	• Pupils use their problem solving and measuring skills to make models to represent how the weight of something changes depending on the amount of gravity. See The Ogden Trust, Planetary Picnic activity, https://www.ogdentrust.com/resources/phizzi-practical-planetary-picnic
	• Explore negative numbers in the context of the surface temperatures of planets. See https://solarsystem.nasa.gov/resources/681/solar-system-temperatures/
	• Create scale models of the planets/solar system. See https://nrich.maths.org/7753
	• Look at pictures of the different phases of the Moon and estimate what percentage/fraction of it's surface is illuminated/not illuminated.

	• This topic provides the opportunity to discuss place value in relation to very large numbers in the context of:
	  ○ Planetary distances from the Sun
	  ○ The Moon's distance from the Earth
	  ○ The distance of stars from the Earth
	
	DT
	• Make simple orreries to show the movement of the Earth, Moon and Sun.
	• Make models to show the relative sizes/positions of the different planets.
	
	PSHE
	• Pupils could discuss the ethics/morality of space travel.
	  ○ **Is it right to spend large sums of money on space exploration while so many people live in poverty on Earth?**
	  ○ **Is it right to colonise another planet like Mars before we have solved the climate crisis on Earth?**
	  ○ **Most space exploration can be carried out by probes/robots. Is it right to send humans into space when spaceflight is still potentially dangerous?**
	  ○ **Is/was it right to send animals into space?**
	
	Geography
	• Learn about the geography or the Moon/Mars. Identify similarities and differences with the Earth.
	
	History
	• Learn how our knowledge and understanding of Space/the Solar System has changed over time. See Ogden Trust for supporting resources:
	  ○ https://www.ogdentrust.com/resources/scientific-ideas-over-time-history-of-the-universe
	  ○ https://www.ogdentrust.com/resources/timeline-card-sort-game-moon-landings
	  ○ https://www.ogdentrust.com/resources/research-cards-earth-and-space
	• Research the history of Moon exploration, https://www.ogdentrust.com/resources/research-cards-moon-landings
	
	Music/Art
	• Learn about the music and art that was recorded on the golden disk which is on the Voyager 1 space probe. See https://voyager.jpl.nasa.gov/golden-record/
	• Learn about Gustav's Holst's The Planet Suite.
	
	PE
	• Use the Mission X 'train like and astronaut' resources during PE lessons, https://www.stem.org.uk/missionx
	• Learn about the exercise regime of astronauts on the International Space Station.
	• Learn about the effects that being in Space has on the human body.

Unit and Vocabulary	Intent - statutory and non-statutory *(in italics)* content – Substantive (knowledge)	Intent –statutory and relevant non-statutory *(in italics)* content-Disciplinary (skills)
Forces Move, movement, surfaces, forces, push, pull, contact, distance, magnet, bar magnet ring magnet, horseshoe, magnet, attract, repel, poles (of magnets), magnetic materials **<u>New Vocabulary</u>** **Force, gravity, Earth, air resistance, water resistance, friction, mechanisms, simple machines, levers, pulleys, gears**	**Pupils should be taught to:** • explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object. • identify the effects of air resistance, water resistance and friction that act between moving surfaces. • recognise that some mechanisms, including levers, pulleys, and gears, allow a smaller force to have a greater effect.	**Pupils should be taught to:** • plan different types of scientific enquiries to answer their own questions, including recognising and controlling variables where necessary. • use test results to make predictions to set up further comparative and fair tests. • use a range of scientific equipment to take accurate and precise measurements or readings, with repeat readings where appropriate. • record data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar, and line graphs. • report and present findings from enquiries, including conclusions and causal relationships, in oral and written forms such as displays and other presentations, using appropriate scientific language. • explain degree of trust in results. • draw conclusions, explain, and evaluate their methods and findings, communicating these in a variety of ways.

Implementation-activity examples and cultural capital opportunities	**Observing over time** • Observe how long it takes different pendulums to stop swinging. Key question • **How long does a pendulum swing for before it stops?** **Pattern Seeking** • Identify patterns in the data from the comparative/fair tests (see below). Key questions • **Do all objects fall through water in the same way?** • **How does the surface area of an object affect how it falls through water?** • **How does surface area of parachute affect the time it takes to fall?** **Identifying and Classifying** • Identify the forces acting in photographs of different scenarios e.g., a child on a swing, someone parachuting out of an aeroplane. • Identify areas of high and low friction around the school/school grounds. This can be done by dragging a weighted container (like an empty margarine tub) over a surface with a forcemeter. Pupils could design posters to warn about slip hazards and produce friction maps of the school. Key questions • **Can you label and name all the forces acting on the objects in each of these situations?** • **Which areas of the school/school grounds have high/low friction?** **Comparative and Fair Testing** • Carry out comparative/fair tests to investigate the effects of water resistance in a range of contexts e.g., dropping shapes (made out of plasticine or modelling clay) through water and pulling shapes, such as boats, along the surface of water. • Carry out comparative/fair tests into air resistance e.g., making parachutes/paper helicopters with different sized canopies/rotor blades and seeing what effect this has on the speed of descent. • Carry out comparative tests to investigate the effect that pulleys have on the force required to lift an object. Start by lifting an object with a force meter. Then add a pulley and repeat. Continue to add pulleys and record the amount of force required. • Investigate how much 'grip' different types of shoe have. See The Ogden Trust for more information, https://www.ogdentrust.com/resources/phizzi-enquiry-slippy-shoes

Key questions

- **How does the angle of launch affect how far a paper rocket will go?**
- **How does the surface area of an object affect the time it takes to sink?**
- **How does the size of a parachute's canopy/paper helicopters rotor blades effect how long it takes to fall to the ground?**
- **Which shoe is the most slippy?**
- **Which shape parachute takes the longest to fall?**

Researching using secondary sources

- Research how a submarine is able to sink and float.
- Research how our ideas of friction and gravity have changed over time. See The Ogden Trust for more information, https://www.ogdentrust.com/resources/research-cards-friction and https://www.ogdentrust.com/resources/research-cards-gravity

Key question

- **How do submarines sink if they are full of air?**

Exploring and Problem Solving

- Explore playground equipment and identify which areas are designed to have high and low friction e.g. steps are rough, a slide is smooth etc.
    - Pupils could design their own playground equipment and identify where there will be high/low friction and why.
- Pupils could explore forces in the context of rollercoasters and design their own rollercoaster.
- Learners could draw arrows onto a picture of Earth to show the direction gravity pulls in.
- Explore the effect of friction in a range of contexts e.g., trainers, bathmats, mats for a helter-skelter.
- Make a product that involves a lever, pulley, or gear.
- Create a timer that uses gravity to move a ball.
- Investigate which design of paper airplane flies the furthest. See Explorify for more information, https://explorify.uk/en/activities/problem-solvers/paper-planes
- Use the Colorado Phet simulations to explore forces, https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html&sort=alpha&view=grid
- Based on their learning, challenge pupils to think of new questions they'd like to investigate about forces – where possible enable them to do investigations to answer them.

Key questions

- **How can we create a timer that uses gravity?**
- **Which paper airplane flies the furthest?**

	Cultural capital opportunities **Sustainable Development Goals**: **Climate change links:** Explore how more aerodynamic designs can make cars/lorries/aeroplanes more fuel efficient and reduce harmful pollution/gas emissions. **Visits/trips**: A local science centre. A factory making cars/aeroplanes/ships. **Visitors:** A physicist, an automotive/aeronautical/nautical engineer/designer. See STEM Ambassadors, https://www.stem.org.uk/stem-ambassadors **Scientists:** Galileo Galilei (Gravity and Acceleration), Isaac Newton (Gravitation), Archimedes of Syracuse (Levers), John Walker (The Match) **Enrichment experiences:** • Explore gravity and air resistance by making and launching 'film canister' or 'bottle' rockets.
Subject Links	**English** • Write a short science fiction story based on the premise, 'what if friction/gravity stopped?' Related texts ○ The Enormous Turnip, (Katie Daynes) ○ Leonardo's Dream, (Hans de Beer) ○ The Aerodynamics of Biscuits, (Clare Helen Welsh) ○ The Lighthouse Keeper's Lunch — Ronda & David Armitage **Maths** • Find the area of a parachute or the sail of a model boat. • Present data from investigations into air/water resistance in bar and line graphs. • Investigate changing the angle that a paper rocket or canon is launched at and what impact this has on how far it travels. For more information on 'paper canons' see, https://www.rigb.org/families/experimental/rubber-band-cannons • When launching film canister or bottle rockets increase the amount of water by a specific fraction or percentage. • See Earth and Space above for 'gravity maths' activities. **Computing/Technology** • Use the Colorado Phet simulations to explore forces, https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html&sort=alpha&view=grid **DT** • Make parachutes, model boats and rockets to investigate gravity and air/water resistance. • Use fair/comparative tests to evaluate the effectiveness of existing products e.g., which trainer has the most grip? • Make a product that involves a lever, pulley, or gear. • Create a timer that uses gravity to move a ball.

	History • Learn about how our ideas of friction and gravity have changed over time. See The Ogden Trust for more information, https://www.ogdentrust.com/resources/research-cards-friction and https://www.ogdentrust.com/resources/research-cards-gravity **PE** • During PE lessons pupils can experience and explore a range of forces e.g. air resistance and friction while running.

Criteria to assess readiness for next year group	**Working scientifically (these criteria are to be achieved by the end of UKS2)** The pupil can, using appropriate scientific language from the national curriculum: • describe and evaluate their own and others' scientific ideas related to topics in the national curriculum (including ideas that have changed over time), using evidence from a range of sources • ask their own questions about the scientific phenomena that they are studying, and select the most appropriate ways to answer these questions, recognising and controlling variables where necessary (i.e., observing changes over different periods of time, noticing patterns, grouping, and classifying things, carrying out comparative and fair tests, and finding things out using a wide range of secondary sources) • use a range of scientific equipment to take accurate and precise measurements or readings, with repeat readings where appropriate • record data and results using scientific diagrams and labels, classification keys, tables, scatter graphs, bar, and line graphs • draw conclusions, explain, and evaluate their methods and findings, communicating these in a variety of ways • raise further questions that could be investigated, based on their data and observations. **Science content** The pupil can: • describe and compare different reproductive processes and life cycles in animals [year 5] • group and identify materials [year 5], in different ways according to their properties, based on first-hand observation; and justify the use of different everyday materials for different uses, based on their properties [year 5] • identify and describe what happens when dissolving occurs in everyday situations; and describe how to separate mixtures and solutions into their components [year 5] • identify, with reasons, whether changes in materials are reversible or not [year 5] • describe the effects of simple forces that involve contact (air and water resistance, friction) [year 5] and gravity [year 5] • identify simple mechanisms, including levers, gears and pulleys, that increase the effect of a force [year 5] • describe the shapes and relative movements of the Sun, Moon, Earth and other planets in the solar system; and explain the apparent movement of the sun across the sky in terms of the Earth's rotation and that this results in day and night [year 5].

Implementation-activity examples and cultural capital opportunities	**Observing over time** • Grow and observe plants that reproduce asexually e.g., strawberries, spider plants, potatoes. • Plant bulbs and then harvest to see how they multiply. • Make first-hand observations of the life-cycles of a range of animals e.g. chickens, butterflies, snails, frogs, brine shrimps* Key questions • **How do potato plants grow and reproduce?** • **Where there any changes when we harvested our bulbs?** • **How do chickens/butterflies/snails change and develop?** **Pattern Seeking** • Compare the gestation times for mammals and look for patterns e.g., in relation to size of animal or length of dependency after birth. • Look for patterns between the size of an animal and its expected life span. Key questions • **Is there a relationship between the size of a mammal and its gestation period?** • **Is there a relationship between the size of a mammal and how long its young are dependent after birth***?* **Identifying and Classifying** • Compare this collection of animals based on similarities and differences in their lifecycle. Key questions • **What are the similarities and differences in the lifecycles of these animals?** • **How could you sort these animals based on their lifecycles?** **Comparative and Fair Testing** • Change the conditions that brine shrimp eggs are in (e.g., the amount of salt) and observe the impact this has on hatching time. Key question • **How does the level of salt affect how quickly brine shrimp hatch?** **Researching using secondary sources** • Use secondary sources to find out about pollination. • Research the differences between the lifecycle of an insect/mammal, bird/fish etc. Key questions • **What are the differences between the life cycle of an insect and a mammal?** • **What is the process of pollination?**

Exploring and Problem Solving

- Explore unusual lifecycles e.g., Marsupials, Seahorses or egg laying mammals like Platypuses/Echidnas.
- Explore the lifecycles of a range of mammals, insects, fish and birds.
- Explore ways of presenting different lifecycles including using drawings, drama and making models.
- Explore ways of presenting the process of pollination including using drawings, drama and making models.
- Explore the question, *which pollinators visit our school grounds?* See Explorify for more information, https://explorify.uk/en/activities/the-big-question/which-pollinators-visit-our-school-grounds
- Based on their learning, challenge pupils to think of new questions they'd like to investigate about living things and their habitats – where possible enable them to do investigations to answer them.

Key questions

- **What is the lifecycle of a platypus? How is this different to other mammals?**
- **What are the similarities/differences between the lifecycles of a horse and an elephant? A blue tit and a Golden Eagle?**

Cultural capital opportunities

Sustainable Development Goals: 13 Climate Action, 14 Life below land, 15 Life on land
Climate change links: Learn about the impact that climate change is having on the lifecycle of animals and plants. Explore how the early onset of spring negatively impacts on the life cycle of animals and plants.
Visits/trips: A local zoo or wildlife centre. A botanic garden or garden centre/nursery. An arable farm
Visitors: A biologist, zoologist, or vet. A gardener/farmer. See Encounter Edu, https://encounteredu.com/.
See Farmer Time https://leaf.eco/farmertime/home
Scientists: James Brodie of Brodie (Reproduction of Plants by Spores)
David Attenborough (Naturalist and Nature Documentary Broadcaster)
***Make sure pupils are exposed to a diverse range of scientists including scientists who are working today. See,**

- **The PSTT** https://pstt.org.uk/resources/curriculum-materials/ASJLM **&** https://pstt.org.uk/resources/curriculum-materials/Science-at-Work
- **The Ogden Trust** https://www.ogdentrust.com/resources/research-cards-women-in-physics
- **STEM Sisters** http://www.hmdt.org.uk/hmdtmusic/stemsisters/the-stem-sisters-2/
- **Oxford Sparks** https://www.oxfordsparks.ox.ac.uk/justaddimagination **for resources to support this.**

Enrichment experiences:

- Pupils could rear animals from young to adulthood e.g., chicks.
- Pupils could keep tadpoles or caterpillars and observe their lifecycle.
- Pupils could keep native species of snail and observe their lifecycle from egg to fully grown snail.

Subject Links	

English

- Pupils write their own version of 'The Tadpole's Promise by Jeanne Willis.
- Pupils write a story based on the life cycle of an animal inspired by stories like 'The Very Hungry Caterpillar' by Eric Carle or 'The Tadpoles Promise'.

Related texts

- The Land of Neverbelieve, (Norman Messenger)
- Mummy Laid an Egg, (Babette Cole)
- Tadpole's Promise—Jeanne Willis & Tony Ross
  - **What are the similarities and differences in the life cycles of a frog and a butterfly?**
  - **What other insects go through metamorphosis?**
- Cicada—Shaun Tan
  - **How is a real cicada's life cycle similar/different to the one in the story?**
- The Boy in the Tower—Polly Ho-Yen
  - **How do different plants reproduce?**
  - **Which plants reproduce using spores?**

Maths

- Measure and compare the growth rates of different plants.
- Measure the increase of mass in potatoes when they are harvested.
- Convert gestation times for different animals into hours/seconds.

Computing/Technology

- Present information about life cycles using PowerPoint or Google Slides.
- Make simple stop-frame animations to show the life cycles of animals.

DT

- Make models to show the life cycles of animals.

Geography

- Learn about where different animals are found in the UK/ world.

Unit and Vocabulary	Intent - statutory and non-statutory *(in italics)* content – Substantive (knowledge)	Intent –statutory and relevant non-statutory *(in italics)* content-Disciplinary (skills)
Animals including humans names of common animals: fish, amphibians, reptiles, birds, mammals, carnivores, herbivores, omnivores, human, body, senses, see, hear, feel, smell, taste, habitat, local environment, pet, wild animal, insect, minibeast, food, eat, head, neck, body, arms, legs, ears, eyes, nose, mouth, tongue, hands, feet, fingers, toes, elbows, knees, hair, teeth grow, healthy, offspring, adults, young, water, air, survive, exercise, hygiene, egg, chick, chicken, caterpillar, pupa, moth, butterfly, tadpole, frog, frog spawn, lamb, sheep, calf, cow, foal, horse, nutrition, diet, skeleton, muscles, protection, support, movement, bones skull, shell, digestive system, stomach, small intestine, large intestine, oesophagus types of teeth: molar, premolar, incisor, canine saliva **New Vocabulary** **Puberty, gestation period, embryo**	**Pupils should be taught to:** • describe the changes as humans develop to old age. • *Pupils should draw a timeline to indicate stages in the growth and development of humans. They should learn about the changes experienced in puberty.*	**Pupils should be taught to:** • report and present findings from enquiries, including conclusions and causal relationships, in oral and written forms such as displays and other presentations, using appropriate scientific language.

Implementation-activity examples and cultural capital opportunities	**Observing over time** • Look at pictures of different animal's embryos and observe how they change over time. Key question • **How do different animal embryos change?** **Pattern Seeking** • Measure the height of everyone in the class and identify any patterns. • Measure pupils from different year groups and identify any patterns. • Measure the handspans of pupils in the class. Key questions • **Are the oldest pupils in our class/school the tallest?** • **Does the tallest person had the widest handspan?** **Identifying and Classifying** • Use photographs to identify the different stages of the human life cycle. Key question • **Can you identify all the stages in the human life cycle?** **Comparative and Fair Testing** • Test the reaction times of differently aged people including adults and identify any patterns in the data. Reaction times can be tested using a ruler. • Measure the height of everyone in the class. Re-measure regularly and compare growth rates between boys and girls. Key questions • **How does age affect a human's reaction time?** • **Who grows the fastest, girls or boys?** **Researching using secondary sources** • Research average life expectancy in different countries and how this has changed significantly in the last hundred years. • Research what happens to the human body as it ages. Key questions • **How has average life expectancy changed in the UK?** • **How does average life expectancy in the UK compare to other countries?** • **Why do people get grey/white hair when they get older?**

	Exploring and Problem Solving • Explore the impacts that an aging society will have and how we can stay fit and healthy into old age. See Explorify, https://explorify.uk/en/activities/the-big-question/how-can-we-stay-fit-and-healthy-as-we-get-older • Through a whole class discussion explore, 'what if the average life-span of a human was 200?' See Explorify, https://explorify.uk/en/activities/what-if/the-average-lifespan-of-a-human-was-200 • Based on their learning, challenge pupils to think of new questions they'd like to investigate about humans – where possible enable them to do investigations to answer them. Key question • **How can we stay fit and healthy as we get older?** **Cultural capital opportunities:** **Climate change links:** Learn about the impact that climate change might have on average human life expectancy. **Visits/trips**: A local day care centre for the elderly. **Visitors:** An elderly person. **Scientists:** Dr Steve Jones (Geneticist) Prof Robert Winston (Human Scientist)
Subject Links	**English** • Write a short science fiction based on the premise, *'what if everyone stopped aging?'* Related texts • Hair in Funny Places, (Babette Cole) • Giant, (Kate Scott) • You're Only Old Once! (Dr. Seuss) **Maths** • Investigate the weight of a human embryo during the different stages of development. • Find the mean, mode and median height in the class. Find average reaction times for an individual or group. **Geography** • Investigate how life expectancy varies around the world and why this is. **History** • Average life expectancy in the UK has increased dramatically since the beginning of the Victorian era. Investigate how and why life expectancy has changed in the UK. **Art** • Explore how humans age and change through the self-portraits of Rembrandt and other artists.

Unit and Vocabulary	Intent - statutory and non-statutory *(in italics)* content – Substantive (knowledge)	Intent –statutory and relevant non-statutory *(in italics)* content-Disciplinary (skills)
Properties and changes of materials everyday materials, wood, paper, plastic, metal, glass, water, rock, brick, stone, fabric, material, foil, elastic, dough, rubber, card, cardboard, clay, object, make/made, hard/soft, shiny/dull, stretchy/stiff, rough/smooth, bendy/not bendy, waterproof/not waterproof, transparent/opaque, absorbent/not absorbent, squash, twist, bend, stretch **<u>New Vocabulary</u>** **Properties, hardness, solubility, transparency, magnetism, solution, substance, separating, mixing, filtering, sieving** **reversible change, burning** **rusting, reactions, irreversible change, thermal/electrical insulator/conductor, change of state, mixture, dissolve, solution, soluble, insoluble, filter, sieve, reversible/non-reversible change, new material**	**Pupils should be taught to:** • compare and group together everyday materials based on their properties, including their hardness, solubility, transparency, conductivity (electrical and thermal), and response to magnets. • know that some materials will dissolve in liquid to form a solution and describe how to recover a substance from a solution. • use knowledge of solids, liquids, and gases to decide how mixtures might be separated, including through filtering, sieving, and evaporating. • give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials, including metals, wood and plastic. • demonstrate that dissolving, mixing and changes of state are reversible changes. • explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda. • *Pupils should build a more systematic understanding of materials by exploring and comparing the properties of a broad range of materials, including relating these to what they learnt about magnetism in year 3 and about electricity in year 4.* • *They should explore reversible changes, including, evaporating, filtering, sieving, melting and dissolving, recognising that melting and dissolving are different processes.*	**Pupils should be taught to:** • plan different types of scientific enquiries to answer their own questions, including recognising and controlling variables where necessary. • use test results to make predictions to set up further comparative and fair tests. • use a range of scientific equipment to take accurate and precise measurements or readings, with repeat readings where appropriate. • record data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar, and line graphs. • report and present findings from enquiries, including conclusions and causal relationships, in oral and written forms such as displays and other presentations, using appropriate scientific language. • explain degree of trust in results. • draw conclusions, explain, and evaluate their methods and findings, communicating these in a variety of ways.

	• *Pupils should explore changes that are difficult to reverse, for example, burning, rusting and other reactions, for example, vinegar with bicarbonate of soda.* • *They should find out about how chemists create new materials, for example, Spencer Silver, who invented the glue for sticky notes or Ruth Benerito, who invented wrinkle-free cotton.*	
Implementation-activity examples and cultural capital opportunities	**Observing over time** • Investigate what happens to saltwater when left to evaporate. Explore this as a means of separating a dissolved solid from a liquid. • Observe what happens to a soluble solid when placed in a liquid. • Observe the process of rusting by putting nails into water. Alternatively place a small amount of wire wool into vinegar for 2 minutes. Then expose to the air for 20 mins and observe what happens – it will rapidly rust. Key questions • **How does a container of saltwater change over time?** • **How does a sugar cube change as it is put in a glass of water?** • **How does a nail in saltwater change over time?** • **What happens to wire wool once it has been soaked in vinegar and then exposed to the air?** **Pattern Seeking** • Fair tests into dissolving rates (see below) will provide opportunities to identify patterns in data. • Investigate the stretchiness of different rubber bands by hanging weights on them and measuring how far they stretch. Key questions • **Does the width/thickness of a rubber band affect how stretchy it is?** • **Do all stretchy materials stretch in the same way?** • **How does temperature affect how much solute we can dissolve?** **Identifying and Classifying** • Provide a range of materials to be sorted based on their properties. Key questions • **How could you sort these materials into different groups?** • **Which of these materials are soluble, transparent, conductors/insulators (thermal/electrical)?** • **How could you find out which of these materials are soluble, transparent, conductors/insulators (thermal/electrical)?**	

	Comparative and Fair Testing
	• Carry out fair tests to investigate the properties of different materials in order to recommend materials for particular functions depending on these properties e.g., test waterproofness and thermal insulation to identify a suitable fabric for a coat.
	• Carry out fair tests to investigate what effects the rate that sugar/salt dissolves at e.g., temperature of the liquid or number of stirs.
	• Carry out comparative and fair tests involving non-reversible changes e.g.
	  ○ putting nails into different types of water (tap, salt, mineral), liquid (cooking oil, milk, coke etc) or water containing different amounts of salt.
	  ○ Changing the amount of sugar/yeast or water temperature.
	Key questions
	• **Which materials should we use to make a coat? Why?**
	• **How does the temperature of tea/water affect how long it takes for a sugar cube to dissolve?**
	• **Which type of sugar dissolves the fastest?**
	• **What affects the rate of rusting?**
	• **What affects the amount of gas produced?**
	
	Researching using secondary sources
	• Research new materials produced by chemists e.g., Spencer Silver (glue of sticky notes) and Ruth Benerito (wrinkle free cotton).
	• Research the impact that plastics are having on the world.
	Key question
	• **What are microplastics and why are they harming the planet?**
	
	Exploring and Problem Solving
	• Explore ways that the process of dissolving could be represented using drawings or drama.
	• Explore adding a range of solids to water and other liquids e.g., cooking oil, as appropriate.
	• Investigate which materials are best for making a spacesuit and then design one. See Explorify for more information, https://explorify.uk/en/activities/problem-solvers/suits-you
	• Explore how to clean water using a molecular sieve. See the relevant PSTT I Bet You Didn't Know article, https://pstt.org.uk/resources/curriculum-materials/cutting-edge-science-primary-schools
	• Learn about the disastrous effects of historical ink. See the relevant PSTT I Bet You Didn't Know article, https://pstt.org.uk/resources/curriculum-materials/cutting-edge-science-primary-schools
	• Explore the science of hand washing. See the relevant PSTT I Bet You Didn't Know article, https://pstt.org.uk/resources/curriculum-materials/cutting-edge-science-primary-schools
	• Based on their learning, challenge pupils to think of new questions they'd like to investigate about the properties and changes of materials – where possible enable them to do investigations to answer them.

	Key questions • **How can we represent the process of dissolving?** • **What materials should a spacesuit be made from and why?** **Cultural capital opportunities** **Sustainable Development Goals**: 6 Clean water & Sanitation, 9 Industry, innovation & infrastructure, 11 Sustainable cities & communities. **Climate change links:** Concrete and steel are both the products of irreversible changes. The manufacture of these materials produces large amounts of greenhouse gases. Pupils could learn about the need to reduce our use of these materials and develop more environmentally friendly ways of making them. **Visits/trips**: Factories where materials are being made. A local science centre. **Visitors:** A chemist or materials scientist. See STEM Ambassadors, https://www.stem.org.uk/stem-ambassadors **Scientists:** Spencer Silver, Arthur Fry and Alan Amron (Post-It Notes) Ruth Benerito (Wrinkle-Free Cotton) **Enrichment experiences:** • Make concrete or bake bread/cakes/biscuits to explore other types of irreversible change. • Make a solar still, https://www.wikihow.com/Build-a-Still • Learn about new cutting-edge materials like Animate materials, https://royalsociety.org/topics-policy/projects/animate-materials/ • Begin to learn about and explore the Periodic Table. Pupils could learn about a different elements – tell pupils not to touch any dangerous chemicals and to only search for elements with a responsible adult. The Royal Society of Chemistry has an interactive Periodic Table, https://www.rsc.org/periodic-table/
Subject Links	**English** • Write consumer reports about products that pupils have evaluated using fair and comparative tests. Related texts • Itch, (Simon Mayo) • Kensuke's Kingdom, (Michael Morpurgo) • The BFG, (Roald Dahl) • Stick Dog Dreams of Ice Cream—Tom Watson ○ **Which material will be best to keep our ice cream solid?** **Maths** • Investigating dissolving rates (see Fair Test above) will provide opportunities for pupils to present data in line graphs, read scales (on thermometers) and use and apply their knowledge of time. **DT** • Use fair/comparative tests to evaluate the effectiveness of existing products e.g., which kitchen roll is most absorbent? Which gloves keep our hands warmest?

	Geography • Explore where materials that we use come from (both within the UK and globally). • Learn about salt pans and how salt is produced in hot parts of the world. • Learn about the impact of plastic pollution on the World's oceans. **History** • Learn about the role that early Arabic scientists played in our understanding of chemical processes like dissolving and irreversible changes. See 1001 Inventions for more information, https://www.1001inventions.com/ especially, https://www.1001inventions.com/initiatives/alchemy-to-chemistry/ • Learn about the development of a material like plastic or steel. **PE** • Some pupils could be particles in a soluble solid while others are particles in a liquid. The 'solid' particles spread among the 'liquid' particles.

Unit and Vocabulary	Intent - statutory and non-statutory *(in italics)* content – Substantive (knowledge)	Intent –statutory and relevant non-statutory *(in italics)* content-Disciplinary (skills)
Earth and Space Seasons, seasonal change, spring, summer, autumn, winter, weather, sun, sunshine, rain, snow, sleet, ice, frost, fog, cloud, hot, cold, storm, sky, earth, night, day **<u>New vocabulary</u>** **Earth, Sun, Moon, (Mercury, Jupiter, Saturn, Venus, Mars, Uranus, Neptune), spherical, solar system, rotates, rotation, star, orbit, planets, satellite**	**Pupils should be taught to:** • describe the movement of the Earth, and other planets, relative to the Sun in the solar system. • describe the movement of the Moon relative to the Earth. • describe the Sun, Earth, and Moon as approximately spherical bodies. • use the idea of the Earth's rotation to explain day and night and the apparent movement of the Sun across the sky. • *Pupils should be introduced to a model of the Sun and Earth that enables them to explain day and night.* • *Pupils should learn that the Sun is a star at the centre of our solar system and that it has eight planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune (Pluto was reclassified as a 'dwarf planet' in 2006).* • *They should understand that a moon is a celestial body that orbits a planet (Earth has one moon; Jupiter has four large moons and numerous smaller ones).* • ***Note: Pupils should be warned that it is not safe to look directly at the Sun, even when wearing dark glasses.*** • *Pupils should find out about the way that ideas about the solar system have developed, understanding how the geocentric model of the solar system gave way to the heliocentric model by considering the work of scientists such as Ptolemy, Alhazen and Copernicus.*	**Pupils should be taught to:** • report and present findings from enquiries, including conclusions and causal relationships, in oral and written forms such as displays and other presentations, using appropriate scientific language. • draw conclusions, explain, and evaluate their methods and findings, communicating these in a variety of ways. • identify and evaluate scientific evidence (their own and others') that has been used to support or refute ideas or arguments. • describe and evaluate their own and others' scientific ideas related to topics in the national curriculum (including ideas that have changed over time), using evidence from a range of sources.

Implementation-activity examples and cultural capital opportunities	**Observing over time** • Keep a 'Moon diary' over the course of a month, sketching/photographing the Moon whenever possible. • Make first-hand observations of how shadows caused by the Sun change through the day and relate this to the rotation of the Earth. Key questions • **Can you observe and identify all the phases in the cycle of the Moon?** • **How does your shadow change over the course of a day?** **Pattern Seeking** • Provide pupils with data relating to the planets in the solar system (e.g. size, distance from the Sun, average surface temperature) and challenge them to identify patterns. Information about the average surface temperature of the planets can be found at, https://solarsystem.nasa.gov/resources/681/solar-system-temperatures/ Key questions • **Is there a pattern between the distance a planet is from the Sun and the length of its orbit?** • **Is there a pattern between the size of a planet and the time it takes to travel around the Sun?** • **Is there a pattern between the distance a planet is from the Sun and its average surface temperature?** **Identifying and Classifying** • Sort pictures of different objects in the solar system into groups using Venn, Carrol or branching databases. Key question • **How could you organise all the objects in the solar system into groups?** **Comparative and Fair Testing** • Fill a tray with flour. Sprinkle some cocoa powder on top. Investigate dropping balls into the tray to make craters. The height, size or angle could be changed. Key questions • **What effect does dropping the ball from different heights have on the width/depth of the crater?** • **What effect does dropping different sized balls have on the width/depth of the crater?** **Researching using secondary sources** • Research how our knowledge and understanding of the solar system has changed over time. Key question • **How have our ideas about the solar system changed over time?** **Exploring and Problem Solving** • Develop ways of demonstrating the movement of the Moon, Earth and Sun in relation to each other including the use of role play/drama and models e.g. different sized balls could be used to represent the Earth, Moon and Sun. • Use secondary sources to help make a model to show why day and night occur. • Explore how sundials.

	• Make simple sundials • Explore the question, *who should own space?* See Explorify for more information, https://explorify.uk/en/activities/the-big-question/who-should-own-space • Explore the question, *how many stars can we see?* See Explorify for more information, https://explorify.uk/en/activities/the-big-question/how-many-stars-can-we-see • Explore the weather on Neptune. See 'There is a storm coming and it is not going away' article on the PSTT I Bet You Didn't Know resource, https://pstt.org.uk/resources/curriculum-materials/cutting-edge-science-primary-schools • Based on their learning, challenge pupils to think of new questions they'd like to investigate about Earth and Space – where possible enable them to do investigations to answer them. **Cultural capital opportunities** **Climate change links:** Pupils could debate whether we should be trying to live on new planets like Mars rather than safeguarding the future of planet Earth. **Visits/trips**: A local planetarium/science centre. **Visitors:** A mobile planetarium. An amateur astronomer. An astrophysicist. See STEM Ambassadors, https://www.stem.org.uk/stem-ambassadors **Scientists:** • Claudius Ptolemy and Nicolaus Copernicus (Heliocentric vs Geocentric Universe) • Yuri Gagarin (First human in space) • Neil Armstrong (First man on the Moon) • Valentina Tereshkova (First woman into space) • Mae Jemison (First black woman in space) • Maggie Aderin Pocock (Astronomer and science communicator, co-host of CBeebies Stargazing & The Sky at Night) • Helen Sharman (First British astronaut) • Tim Peake (First British ESA astronaut) • Katherine Johnson, Mary Jackson, Dorothy Vaughan (NASA mathematicians featured in the book and film, Hidden Figures) • Jocelyn Bell, (Astro-physicist who discovered pulsars) **Enrichment experiences:** • Hold a stargazing evening at your school. See The Ogden Trust for guidance, https://www.ogdentrust.com/resources/how-to-run-stargazing-events-for-pupils-and-parents • Arrange to observe the Sun using solar telescopes. *This must only be carried out by experienced astronomers.

Subject Links	

English

- Write a newspaper article about a significant event in space exploration.
- Write a diary entry in the character of a famous astronaut or space scientist.

Related texts

- The Skies Above My Eyes,
- (Charlotte Guillain & Yuval Zommer)
- George's Secret Key to the Universe, (Lucy and Stephen Hawking with Christophe Galfard)
- The Way Back Home, (Oliver Jeffers)
- Look Up! (Nathan Bryon)
- What Miss Mitchell Saw, (Hayley Barrett)
- Caroline's Comets, (Emily Arnold McCully)
- The Astronaut with a Song for the Stars, (Julia Finley Mosca)
- Interstellar Cinderella, (Deborah Underwood)
- Margaret and the Moon, (Dean Robbins)
- Always Looking Up (Laura Gehl)
- The Girl who Named Pluto, (Alice B. McGinty)
- Gutsy Girls go for Science: Astronauts (Alecia Klepeis)
- A Galaxy of her Own (Libby Jackson)
- The Darkest Dark (Chris Hadfield)
- Hidden Figures—Margot Shetterly
    - **How many people does it take to get one person to the Moon?**
    - **What jobs are involved in space exploration?**
- Curiosity, the Story of a Mars Rover—Markus Motum
    - **Can we design a shock-absorbing system that will allow a Mars Rover to land undamaged on the surface of Mars?**

Maths

- Pupils calculate what their age would be on different planets.
- Pupils calculate what their weight would be on different planets.
- Pupils use their problem solving and measuring skills to make models to represent how the weight of something changes depending on the amount of gravity. See The Ogden Trust, Planetary Picnic activity, https://www.ogdentrust.com/resources/phizzi-practical-planetary-picnic
- Explore negative numbers in the context of the surface temperatures of planets. See https://solarsystem.nasa.gov/resources/681/solar-system-temperatures/
- Create scale models of the planets/solar system. See https://nrich.maths.org/7753
- Look at pictures of the different phases of the Moon and estimate what percentage/fraction of it's surface is illuminated/not illuminated.

	• This topic provides the opportunity to discuss place value in relation to very large numbers in the context of:
	  ○ Planetary distances from the Sun
	  ○ The Moon's distance from the Earth
	  ○ The distance of stars from the Earth
	
	DT
	• Make simple orreries to show the movement of the Earth, Moon and Sun.
	• Make models to show the relative sizes/positions of the different planets.
	
	PSHE
	• Pupils could discuss the ethics/morality of space travel.
	  ○ **Is it right to spend large sums of money on space exploration while so many people live in poverty on Earth?**
	  ○ **Is it right to colonise another planet like Mars before we have solved the climate crisis on Earth?**
	  ○ **Most space exploration can be carried out by probes/robots. Is it right to send humans into space when spaceflight is still potentially dangerous?**
	  ○ **Is/was it right to send animals into space?**
	
	Geography
	• Learn about the geography or the Moon/Mars. Identify similarities and differences with the Earth.
	
	History
	• Learn how our knowledge and understanding of Space/the Solar System has changed over time. See Ogden Trust for supporting resources:
	  ○ https://www.ogdentrust.com/resources/scientific-ideas-over-time-history-of-the-universe
	  ○ https://www.ogdentrust.com/resources/timeline-card-sort-game-moon-landings
	  ○ https://www.ogdentrust.com/resources/research-cards-earth-and-space
	• Research the history of Moon exploration, https://www.ogdentrust.com/resources/research-cards-moon-landings
	
	Music/Art
	• Learn about the music and art that was recorded on the golden disk which is on the Voyager 1 space probe. See https://voyager.jpl.nasa.gov/golden-record/
	• Learn about Gustav's Holst's The Planet Suite.
	
	PE
	• Use the Mission X 'train like and astronaut' resources during PE lessons, https://www.stem.org.uk/missionx
	• Learn about the exercise regime of astronauts on the International Space Station.
	• Learn about the effects that being in Space has on the human body.

Unit and Vocabulary	Intent - statutory and non-statutory *(in italics)* content – Substantive (knowledge)	Intent –statutory and relevant non-statutory *(in italics)* content-Disciplinary (skills)
Forces Move, movement, surfaces, forces, push, pull, contact, distance, magnet, bar magnet ring magnet, horseshoe, magnet, attract, repel, poles (of magnets), magnetic materials **<u>New Vocabulary</u>** **Force, gravity, Earth, air resistance, water resistance, friction, mechanisms, simple machines, levers, pulleys, gears**	**Pupils should be taught to:** • explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object. • identify the effects of air resistance, water resistance and friction that act between moving surfaces. • recognise that some mechanisms, including levers, pulleys, and gears, allow a smaller force to have a greater effect.	**Pupils should be taught to:** • plan different types of scientific enquiries to answer their own questions, including recognising and controlling variables where necessary. • use test results to make predictions to set up further comparative and fair tests. • use a range of scientific equipment to take accurate and precise measurements or readings, with repeat readings where appropriate. • record data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar, and line graphs. • report and present findings from enquiries, including conclusions and causal relationships, in oral and written forms such as displays and other presentations, using appropriate scientific language. • explain degree of trust in results. • draw conclusions, explain, and evaluate their methods and findings, communicating these in a variety of ways.
Implementation-activity examples and cultural capital opportunities	**Observing over time** • Observe how long it takes different pendulums to stop swinging. Key question • **How long does a pendulum swing for before it stops?** **Pattern Seeking** • Identify patterns in the data from the comparative/fair tests (see below).	

Key questions

- **Do all objects fall through water in the same way?**
- **How does the surface area of an object affect how it falls through water?**
- **How does surface area of parachute affect the time it takes to fall?**

Identifying and Classifying

- Identify the forces acting in photographs of different scenarios e.g., a child on a swing, someone parachuting out of an aeroplane.
- Identify areas of high and low friction around the school/school grounds. This can be done by dragging a weighted container (like an empty margarine tub) over a surface with a forcemeter. Pupils could design posters to warn about slip hazards and produce friction maps of the school.

  Key questions
  - **Can you label and name all the forces acting on the objects in each of these situations?**
  - **Which areas of the school/school grounds have high/low friction?**

Comparative and Fair Testing

- Carry out comparative/fair tests to investigate the effects of water resistance in a range of contexts e.g., dropping shapes (made out of plasticine or modelling clay) through water and pulling shapes, such as boats, along the surface of water.
- Carry out comparative/fair tests into air resistance e.g., making parachutes/paper helicopters with different sized canopies/rotor blades and seeing what effect this has on the speed of descent.
- Carry out comparative tests to investigate the effect that pulleys have on the force required to lift an object. Start by lifting an object with a force meter. Then add a pulley and repeat. Continue to add pulleys and record the amount of force required.
- Investigate how much 'grip' different types of shoe have. See The Ogden Trust for more information, https://www.ogdentrust.com/resources/phizzi-enquiry-slippy-shoes

Key questions

- **How does the angle of launch affect how far a paper rocket will go?**
- **How does the surface area of an object affect the time it takes to sink?**
- **How does the size of a parachute's canopy/paper helicopters rotor blades effect how long it takes to fall to the ground? Which shape parachute takes the longest to fall?**
- **Which shoe is the most slippy?**

Researching using secondary sources

- Research how a submarine is able to sink and float.
- Research how our ideas of friction and gravity have changed over time. See The Ogden Trust for more information, https://www.ogdentrust.com/resources/research-cards-friction and https://www.ogdentrust.com/resources/research-cards-gravity

Key question

- **How do submarines sink if they are full of air?**

Exploring and Problem Solving

- Explore playground equipment and identify which areas are designed to have high and low friction e.g. steps are rough, a slide is smooth etc.
    - Pupils could design their own playground equipment and identify where there will be high/low friction and why.
- Pupils could explore forces in the context of rollercoasters and design their own rollercoaster.
- Learners could draw arrows onto a picture of Earth to show the direction gravity pulls in.
- Explore the effect of friction in a range of contexts e.g., trainers, bathmats, mats for a helter-skelter.
- Make a product that involves a lever, pulley, or gear.
- Create a timer that uses gravity to move a ball.
- Investigate which design of paper airplane flies the furthest. See Explorify for more information, https://explorify.uk/en/activities/problem-solvers/paper-planes
- Use the Colorado Phet simulations to explore forces, https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html&sort=alpha&view=grid
- Based on their learning, challenge pupils to think of new questions they'd like to investigate about forces – where possible enable them to do investigations to answer them.

Key questions

- **How can we create a timer that uses gravity?**
- **Which paper airplane flies the furthest?**

Cultural capital opportunities

Climate change links: Explore how more aerodynamic designs can make cars/lorries/aeroplanes more fuel efficient and reduce harmful pollution/gas emissions.
Visits/trips: A local science centre. A factory making cars/aeroplanes/ships.
Visitors: A physicist, an automotive/aeronautical/nautical engineer/designer. See STEM Ambassadors, https://www.stem.org.uk/stem-ambassadors
Scientists: Galileo Galilei (Gravity and Acceleration), Isaac Newton (Gravitation), Archimedes of Syracuse (Levers), John Walker (The Match)
Enrichment experiences:

- Explore gravity and air resistance by making and launching 'film canister' or 'bottle' rockets.

Subject Links	

English

- Write a short science fiction story based on the premise, 'what if friction/gravity stopped?'

Related texts

- The Enormous Turnip, (Katie Daynes)
- Leonardo's Dream, (Hans de Beer)
- The Aerodynamics of Biscuits, (Clare Helen Welsh)
- The Lighthouse Keeper's Lunch — Ronda & David Armitage

Maths

- Find the area of a parachute or the sail of a model boat.
- Present data from investigations into air/water resistance in bar and line graphs.
- Investigate changing the angle that a paper rocket or canon is launched at and what impact this has on how far it travels. For more information on 'paper canons' see, https://www.rigb.org/families/experimental/rubber-band-cannons
- When launching film canister or bottle rockets increase the amount of water by a specific fraction or percentage.
- See Earth and Space above for 'gravity maths' activities.

Computing/Technology

- Use the Colorado Phet simulations to explore forces, https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html&sort=alpha&view=grid

DT

- Make parachutes, model boats and rockets to investigate gravity and air/water resistance.
- Use fair/comparative tests to evaluate the effectiveness of existing products e.g., which trainer has the most grip?
- Make a product that involves a lever, pulley, or gear.
- Create a timer that uses gravity to move a ball.

History

- Learn about how our ideas of friction and gravity have changed over time. See The Ogden Trust for more information, https://www.ogdentrust.com/resources/research-cards-friction and https://www.ogdentrust.com/resources/research-cards-gravity

PE

- During PE lessons pupils can experience and explore a range of forces e.g. air resistance and friction while running.

Criteria to assess readiness for next year group	**Working scientifically (these criteria are to be achieved by the end of UKS2)** The pupil can, using appropriate scientific language from the national curriculum: • describe and evaluate their own and others' scientific ideas related to topics in the national curriculum (including ideas that have changed over time), using evidence from a range of sources • ask their own questions about the scientific phenomena that they are studying, and select the most appropriate ways to answer these questions, recognising and controlling variables where necessary (i.e., observing changes over different periods of time, noticing patterns, grouping, and classifying things, carrying out comparative and fair tests, and finding things out using a wide range of secondary sources) • use a range of scientific equipment to take accurate and precise measurements or readings, with repeat readings where appropriate • record data and results using scientific diagrams and labels, classification keys, tables, scatter graphs, bar, and line graphs • draw conclusions, explain, and evaluate their methods and findings, communicating these in a variety of ways • raise further questions that could be investigated, based on their data and observations. **Science content** The pupil can: • describe and compare different reproductive processes and life cycles in animals [year 5] • group and identify materials [year 5], in different ways according to their properties, based on first-hand observation; and justify the use of different everyday materials for different uses, based on their properties [year 5] • identify and describe what happens when dissolving occurs in everyday situations; and describe how to separate mixtures and solutions into their components [year 5] • identify, with reasons, whether changes in materials are reversible or not [year 5] • describe the effects of simple forces that involve contact (air and water resistance, friction) [year 5] and gravity [year 5] • identify simple mechanisms, including levers, gears and pulleys, that increase the effect of a force [year 5] • describe the shapes and relative movements of the Sun, Moon, Earth and other planets in the solar system; and explain the apparent movement of the sun across the sky in terms of the Earth's rotation and that this results in day and night [year 5].