Progression in Materials

National Curriculum statements in red are from other linked topics.

Early learning goal	• Children know about similarities and differences in relation to places, objects, materials and living things. They talk about the features of their own immediate environment and how environments might vary from one another. They make observations of animals and plants and explain why some things occur and talk about changes.
Year 1	• Distinguish between and object and the material from which it is made. • Identify and name a variety of everyday materials, including wood, metal, plastic, glass, water and rock, • Describe the simple physical properties of a variety of everyday materials. • Compare and group together a variety of everyday materials on the basis of their simple properties.
Year 2	• Identify and compare the suitability of a variety of everyday materials, including wood, metal, plastic, glass, brick, rock, paper and cardboard for particular uses. • Find out how shapes of solid objects made from some materials can be changed by squashing, bending, twisting and stretching.
Year 3	• compare and group together different kinds of rocks on the basis of their appearance and simple physical properties • describe in simple terms how fossils are formed when things that have lived are trapped within rock • recognise that soils are made from rocks and organic matter.
Year 4	• compare and group materials together, according to whether they are solids, liquids or gases • observe that some materials change state when they are heated or cooled, and measure or research the temperature at which this happens in degrees Celsius (°C) • identify the part played by evaporation and condensation in the water cycle and associate the rate of evaporation with temperature
Year 5	• compare and group together everyday materials on the basis of 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
Year 6	• Recognise that living things have changed over time and that fossils provide information about living things that inhabited the Earth millions of years ago. (Y6 - Evolution and inheritance)
KS3	• Chemical reactions as the rearrangement of atoms. • Representing chemical reactions using formulae and using equations. • Combustion, thermal decomposition, oxidation and displacement reactions. • Defining acids and alkalis in terms of neutralisation reactions. • The pH scale for measuring acidity/alkalinity; and indicators.

Year 1 – Everyday Materials

National Curriculum Objectives:

- Distinguish between and object and the material from which it is made.
- Identify and name a variety of everyday materials, including wood, metal, plastic, glass, water and rock,
- Describe the simple physical properties of a variety of everyday materials.
- Compare and group together a variety of everyday materials on the basis of their simple properties.

Pupils should explore, name, discuss and raise and answer questions about everyday materials so that they become familiar with the names of materials and properties such as: hard/soft; stretchy/stiff; shiny/dull; rough/smooth; bendy/not bendy; waterproof/not waterproof; absorbent/not absorbent; opaque/transparent.
Pupils should explore and experiment with a wide variety of materials, not only those listed in the programme of study, but including for example: brick, paper, fabrics, elastic, foil.
Pupils might work scientifically by: performing simple tests to explore questions, for example: 'What is the best material for an umbrella? ...for lining a dog basket? ...for curtains? ...for a bookshelf? ...for a gymnast's leotard?'

Prior Learning

In Early Years:

- Children should be able to ask questions about the place they live.
- Talk about why things happen and how things work.
- Discuss the things they have observed such as natural and found objects.
- Manipulates materials to achieve a planned effect.

Key Ideas	Possible Activities
What are objects made from?	• **Link an object to the material(s) it's made from.** • Provide a wide range of objects (could be linked to a theme). Use pupils own words and knowledge to develop material words (e.g. wood, plastic, glass, metal, rock, wool, etc). Write words on laminated cards and display on a word wall. • Using a variety of objects, match them with labels (e.g. plastic, glass, metals, wood, etc). Use items which will prompt discussion e.g. a plastic milk carton, a plastic toy and a plastic folder. Begin to talk about the materials they are made from by describing some properties.
Can you name everyday materials?	• **Confirm materials vocabulary. Begin to link materials to their properties.** • Sensory exploration of materials ('feely bag', observation, circle time). How do different materials feel? Begin a discussion using comparative adjectives for properties (e.g. rough/smooth). Write words on laminated cards. Display on word wall to support linked words (e.g. antonyms). • 'Materials walk' (lists, photos, etc of different materials around school). Include photos in their books (could label with material and/or properties). Encourage recall.
What are the properties of materials?	• **Link a material to its property.** Use a theme to create importance and relevance. • Children have access to lots of scientific words about properties, and lots of objects to feel and investigate. Find an object with one or more than one property e.g. glass is hard and transparent. How many properties can you attribute to any one object? Add property labels. Compare & discuss. • Guessing games to choose which item a child is describing by asking scientific questions (properties). • Team, running game (in hall). Objects in centre. PPT flashes up property(ies). Pupils have to run and choose. Points for getting it right. Add laminated property labels as they go. Compare & discuss. • Make a 'den'. Find appropriate materials to use & why (provide different/same materials per group).
Can you compare the properties of materials?	• **Compare materials by their properties.** • Sort a wide range of objects based on a property, e.g. "hard" or "flexible". Show how something made from the same material may have diverse properties (use plastic example). • Children sort objects/materials by starting with the property (pupils use a word list or recall words).
Which materials would be best and why?	• Link to a theme. Describe or create objects by deciding which materials are best (based upon property). • Evaluate 'dens' by trying them out. Did the materials work well? What would they change? Why? • Children are given the task of designing an object (based upon theme), e.g. a space ship, a bridge, a container for something heavy, superhero cape, etc. Decide what properties would be useful. Group materials (Venn / Carroll diagrams) to decide which would be best. • Discuss which materials would be best to use. Construct/draw object using sample materials (add property labels). Support pupils to begin to give scientific reasons why they have chosen those materials based on what they've observed about their properties.

Vocabulary

Object, material, wood, plastic, glass, metal, water, rock, brick, paper, fabric, elastic, foil, card/cardboard, rubber, wool, clay, hard, soft, stretchy, stiff, bendy, floppy, waterproof, absorbent, breaks/tears, rough, smooth, shiny, dull, see through, not see through

In Year 2:

- Identify and compare the suitability of a variety of everyday materials, including wood, metal, plastic, glass, brick, rock, paper and cardboard for particular uses.
- Find out how shapes of solid objects made from some materials can be changed by squashing, bending, twisting and stretching.

Year 2 – Uses for Everyday Materials

National Curriculum Objectives:

- Identify and compare the suitability of a variety of everyday materials, including wood, metal, plastic, glass, brick, rock, paper and cardboard for particular uses.
- Find out how shapes of solid objects made from some materials can be changed by squashing, bending, twisting and stretching.

Pupils should identify and discuss the uses of different everyday materials so that they become familiar with how some materials are used for more than one thing (metal can be used for coins, cans, cars and table legs; wood can be used for matches, floors, and telegraph poles) or different materials are used for the same thing (spoons can be made from plastic, wood, metal, but not normally from glass).
They should think about the properties of materials that make them suitable or unsuitable for particular purposes and they should be encouraged to think about unusual and creative uses for everyday materials. Pupils might find out about people who have developed useful new materials, for example John Dunlop, Charles Macintosh or John McAdam.
Pupils might work scientifically by: comparing the uses of everyday materials in and around the school with materials found in other places (at home, the journey to school, on visits, and in stories, rhymes and songs); observing closely, identifying and classifying the uses of different materials, and recording their observations.

Prior Learning

In Year 1:

- Distinguish between and object and the material from which it is made.
- Identify and name a variety of everyday materials, including wood, metal, plastic, glass, water and rock,
- Describe the simple physical properties of a variety of everyday materials.
- Compare and group together a variety of everyday materials on the basis of their simple properties.

Key Ideas	Possible Activities
What are things made from?	• From a list of roles/uses (e.g. container, building, decoration, writing, etc). Sort materials into roles. Discuss similarities and differences. Challenge with pictures of all materials being used in roles. Discuss best and why for each purpose. Link to work on properties in year 1. • School walk. Note use of different materials for the same role. Ask why.
Do different materials have different properties?	• Comparative test – waterproofing, scratch testing, bend testing, warmth/insulating, shiny/dull, transparent (see-through)/opaque, etc (link to possible uses). Use a range of equipment to test. • Make umbrellas, rafts, shoes, super-hero capes, etc. Select two relevant properties to support an understanding of combination of properties useful for an application.
Can we change the shape of materials?	• From a range of objects, which can be changed? Which properties prevent you from changing an object? E.g. wood which is thick can't be bent but wood shavings can be. Different metals / plastics. Show DVD clips of metals being forged at a blacksmiths. • Sort items into things which can be twisted, squashed or bent, and things which can't be. Discuss what use these items may have, e.g. to build something strong you need something which won't bend, twist or squash. To make something to wear you need materials which can stretch or be flexible etc. Link to property. • Towers, tunnels & turrets – make the strongest wall or choose the best material for a missile to throw at the wall. Competitive. • Comparative test – effect of heat (blowtorch; demo) on bending / stretching, twist test with playdough (in different water temperatures) • Fair test: (bungee jumping) – thickness of rubber band on stretching with hanging weights • Make rice crispy cakes / crispy Christmas trees
What are solids, liquids & gases?	• Sort a range of materials into solid and liquid. Include melting chocolate, sand and correction fluid. Discuss and build understanding of properties and change. • Blow up a balloon (also over lemonade bottle). Feel air coming out • Demo: boiling water; condensation

Vocabulary

Names of materials – increased range from year 1
Properties of materials - as for year 1 plus opaque, transparent and translucent, reflective, non-reflective, flexible, rigid, shape, push/pushing, pull/puling, twist/twisting, squash/squashing. Bend/bending, stretch/stretching

In Year 4:

- Compare and group materials together, according to whether they are solids, liquids or gases.
- Observe that some materials change state when heated or cooled, and measure and research the temperature at which this happens in degrees Celsius.
- Identify the part played by evaporation and condensation in the water cycle and associate the rate of evaporation with temperature.

In Year 6:

- Recognise that living things have changed over time and that fossils provide information about living things that inhabited the Earth millions of years ago

Year 3 - Rocks

National Curriculum:

- compare and group together different kinds of rocks on the basis of their appearance and simple physical properties
- describe in simple terms how fossils are formed when things that have lived are trapped within rock
- recognise that soils are made from rocks and organic matter.

Pupils might work scientifically by: observing rocks, including those used in buildings and gravestones, and exploring how and why they might have changed over time; using a hand lens or microscope to help them to identify and classify rocks according to whether they have grains or crystals, and whether they have fossils in them. Pupils might research and discuss the different kinds of living things whose fossils are found in sedimentary rock and explore how fossils are formed. Pupils could explore different soils and identify similarities and differences between them and investigate what happens when rocks are rubbed together or what changes occur when they are in water. They can raise and answer questions about the way soils are formed.

Prior Learning

In Year 2:

- identify and compare the suitability of a variety of everyday materials, including wood, metal, plastic, glass, brick, rock, paper and cardboard for particular uses
- find out how the shapes of solid objects made from some materials can be changed by squashing, bending, twisting and stretching.

Key Ideas	Possible Activities
Are there different types of rock?	• Explore different places to find rocks. Introduce that the earth is made out of rock. • Demo: dig a pit (bigger rock is found at deeper depths; should hit bedrock); float pumice in water; break/chip sandstone to show it is made out of finer and finer grains • Could develop understanding of sedimentary (possibly metamorphic & igneous) rock • Collect different types of rock found in different places (e.g. around school, on the beach) • Sort examples of rock (e.g. sandstone, granite, slate, pumice, etc). Identify features that could be used to sort. Sort / re-sort using different criteria. Encourage identification. • Observe & draw rocks. Use hand-lens. Develop vocabulary to describe.
Rocks have lots of uses	• Show pictures of rock used in different ways • Use pictures / school environment to identify rocks (from their collection) and their application. Suggest reasons for use. Record in a table. • Develop 'rock labels' on a diagram or model of a house / school / etc. Link properties to its application. • Which rock is the hardest? (scratch test) • Try making a sandstone sculpture (care! need goggles/gloves) with hammer and chisel; make a clay pot (invite a potter into school), jewelry with coloured pebbles collected from a beach or concrete (care!) • Visit brick factory, quarry, etc
Know how fossils are made	• Examine provided fossils / pictures. Recognise fossils show creatures from millions of years ago. Describe formation. • Research extinct creatures (e.g. trilobites, dinosaurs, etc) • Make a fossil (e.g. shells, plastic animals) – create impression in modeling clay. Cover with plaster of Paris. Alternatively, use coffee granules/flour/salt or press object between two thick slices of bread.
Soils are made from rocks & organic matter	• Use strong hand-lenses / microscopes to examine soils. Draw. Extend for different soils. Develop understanding of rock can be broken into finer and finer grains (model) • Grow vegetables in bags/tubs in class. Care for them to harvest. • Use a soil identification key to classify soil types • Fair test: Which soils let water drain through the fastest? Measure speed of water flow through soil (soil in funnel, filter paper, collect water in measuring cylinder. Time for volume to be collected). Link to gardening / agriculture. • Fair test: What effect does the amount of organic matter have on soil drainage? Add different weights of organic matter to soil.

Vocabulary*

Rock, stone, pebble, boulder, grain, crystals, layers, hard, soft, texture, absorb water, soil, fossil, marble, chalk, granite, sandstone, slate, soil, peat, sandy/chalk/clay soil

In KS3:

- The composition of the Earth.
- The structure of the Earth.
- The rock cycle and the formation of igneous, sedimentary and metamorphic rocks

Year 4 – States of Matter

National Curriculum:

- compare and group materials together, according to whether they are solids, liquids or gases
- observe that some materials change state when they are heated or cooled, and measure or research the temperature at which this happens in degrees Celsius (°C)
- identify the part played by evaporation and condensation in the water cycle and associate the rate of evaporation with temperature

Pupils should explore a variety of everyday materials and develop simple descriptions of the states of matter (solids hold their shape; liquids form a pool not a pile; gases escape from an unsealed container). Pupils should observe water as a solid, a liquid and a gas and should note the changes to water when it is heated or cooled.
Pupils might work scientifically by: grouping and classifying a variety of different materials; exploring the effect of temperature on substances such as chocolate, butter, cream (for example, to make food such as chocolate crispy cakes and ice-cream for a party). They could research the temperature at which materials change state, for example, when iron melts or when oxygen condenses into a liquid. They might observe and record evaporation over a period of time, for example, a puddle in the playground or washing on a line, and investigate the effect of temperature on washing drying or snowmen melting

Prior Learning

In Year 3:

- compare and group together different kinds of rocks on the basis of their appearance and simple physical properties
- describe in simple terms how fossils are formed when things that have lived are trapped within rock
- recognise that soils are made from rocks and organic matter.

Key Ideas	Possible Activities
What makes something a solid, liquid or a gas?	• Provide range of materials demonstrating solid, liquid & gas. Use talking points, e.g. jelly, sand. Generate characteristics of each state through observation and comparison • Use concept cartoons for misconceptions/ understanding • Demo gas: weight deflated/inflated football; hot air balloon; 'popping' test tube (use alka seltzer); bike pump; balloon on lemonade bottle: CO_2 fire extinguisher • Sort and classify examples of each state (before and/or after the generation of characteristics) • Handmade ice cream • Fair test: Which type of sponge holds the most air? Speak & replace with water. Measure volume • Practice using a thermometer accurately (different types including data-loggers)
What are solids, liquids & gases make of?	• Begin to introduce particle model. Link 'state' to 'heat (energy)'. Gas into liquid into solid. Use multi-link • Demos: food colouring into hot/cold water (particle movement); water droplet (particle attraction); heating/cooling effect of a gas (detergent on bottle opening or heated can crushing in cold water) • Pupils model states by pretending to be particles • Use counters to draw annotated diagrams of each state. • Wicking between two glasses. Explore (water cohesion – link to water movement in plants) • Water droplet 'raceway' (surface tension – link to pond skater. Show effect of detergent • Fair test: 'Drops on a penny'. How many drop can you add? Does the type of liquid effect the number of drops added? (salt water, veg oil, etc)
What happens when substances change state?	• Demo: melting chocolate/ice-cream on a hotplate, boiling water in a beaker. Make predictions across a temperature range. Note unusual features (e.g. movement, bubbling). Record observations. • Demo: 'instant freeze' water; fire-resistant water balloon; • Cut ice cubes in half using weighted wire. Explain (link to action of ice skates) • Appoint 'safety champion' to monitor teams performance • Create a 'risk' poster. Use photographs of teams working. Add solutions. • Stretch a curly-whirly. What happens? Warm it; does this change the effect? Link cause & effect. Make 'super-goo' (cornstarch/water; non-Newtonian fluid), fake snot or milk plastic. Explain. • Make chocolate leaves • What is the best way to melt ice-cubes? Explore • Heat ice/water over burner. Measure temperature over time. Record & graph • Fair test: Which type of chocolate/material melts faster? How can we make chocolate melt faster? Explore • Fair test: Do different liquids freeze/melt at different speeds?
What is evaporation & condensation?	• Demo: wet finger; condensation in a bag; sponge and straw in water to represent water transport in plants (link yr3) • Predict what will happens when a cooled metal/glass sheet is placed over boiling water. Collect water as run off. Build labeled diagram to show process & terminology. • Link to drying washing, sweating, etc. Fair test: Which materials dry the fastest? Washing line. Weight difference or press onto paper towel • Fair test: How does the temperature/surface area/substance effect the speed of evaporation (salt water, ink)? • Fair test: How does the temperature effect the speed of condensation (volume of run-off collected from metal sheets cooled to different temperatures over a boiling pan of water (care!)?

Vocabulary*

Solid, liquid, gas, state change, melting, freezing, melting point, boiling point, evaporation, temperature, water cycle

	What happens in the water cycle?	• Demo: ice on Clingfilm over hot water; cloud in a bottle • Link previous expt to water cycle. Set up model. • Design/complete poster to include all terminology. • Help! I'm stuck in a desert with no water! Design the best water condenser	

In Year 5:

- compare and group together everyday materials on the basis of 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.

Year 5 - Properties and changes of material

National Curriculum:

- compare and group together everyday materials on the basis of 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 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.

Pupils might work scientifically by: carrying out tests to answer questions, for example, 'Which materials would be the most effective for making a warm jacket, for wrapping ice cream to stop it melting, or for making blackout curtains?' They might compare materials in order to make a switch in a circuit. They could observe and compare the changes that take place, for example, when burning different materials or baking bread or cakes. They might research and discuss how chemical changes have an impact on our lives, for example, cooking, and discuss the creative use of new materials such as polymers, super-sticky and super-thin materials

Prior Learning

In Year 4:

- compare and group materials together, according to whether they are solids, liquids or gases
- observe that some materials change state when they are heated or cooled, and measure or research the temperature at which this happens in degrees Celsius (°C)
- identify the part played by evaporation and condensation in the water cycle and

Key Ideas	Possible Activities
How does a material's property suit its role?	• 'We are builders' – make houses. Visit building site. Make lists of materials found. Interview builders. • Show pictures of houses/rooms. Say what they are built with and why. Group material types. Compare types of houses. Annotate diagrams • Use building scenarios (e.g. 'hole in the roof', 'insulating a wall', build a bridge, etc) to generate investigations. Architect visit to set scenarios. • Fair test: Which material is best at waterproofing, thermal insulation, electrical conductivity, hardness, transparency, etc? Design & carry out. • Fair test: Which material absorbs the most heat?
What is a solution?	• Develop understanding of dissolving & a solution through particle model (review from yr4). • Difference between a solution (transparent, soluble) and a mixture (cloudy, insoluble) eg. veg oil/water. • Make sugar rock candy/lemonade/stained glass sugar • Fair test: Builders want cups of tea with lots of sugar (granulated or cubes). How does type/amount of sugar/temperature/ volume of water effect how much sugar can dissolve/time to dissolve? • Which materials form solutions and which form mixtures (eg. water, sand, salt, oil, coffee, flour, etc)
How can mixtures be separated?	• Develop understanding of mixtures through particle model. • Demo: techniques for separating mixtures. Seiving, filtering, decanting, evaporating and chromatography. Examples of everyday mixtures. Stress these are reversible reactions • Scenarios: mixed up aggregate, wet sand. Can they explain; how concrete/plaster / paint sets, how tea bag works, different places to dry out socks, etc, using model. • Make a sieve (punch different sized holes in margarine tubs) • Chromatography of M&Ms, Skittles or ink • Evaporation of salt water into fresh using a sun still • Explore: various filters with mixture (soil in water) • Crystalise sugar on a string • Pen detective – decide who wrote the message.

Vocabulary*

Thermal/electrical insulator/conductor, change of state, mixture, dissolve, solution, soluble, insoluble, filter, sieve reversible/non-reversible change, burning, rusting, new material

associate the rate of evaporation with temperature and organic matter.	Reversible & irreversible change	• Concept of irreversible change (reaction, new materials). • Demo: burning of rubbish, toast; action of acid on calcium carbonate (e.g. acid rain on limestone); removing tarnish from silver/coins with baking soda/vinegar; create explosive reaction (baking soda/vinegar, coke/mentos). • Explain how a candle burns (reverible/irreversible). • Make homemade hand warmer / lava lamp / bouncy balls • Make crystals (borax/baking soda), milk plastic, invisible ink, ice cream, slime, • Fair test: What effect has surface area/concentration /temperature of calcium carbonate chips on froth height? Reaction with acid. • Fair test: How long will a candle stay lit in different amounts of air/oxygen? Cover candles with jars.	

In KS3:

- Chemical reactions as the rearrangement of atoms.
- Representing chemical reactions using formulae and using equations.
- Combustion, thermal decomposition, oxidation and displacement reactions.
- Defining acids and alkalis in terms of neutralisation reactions.
- The pH scale for measuring acidity/alkalinity; and indicators.

Fair & comparative testing	Research using secondary sources	Identifying, classifying & grouping	Pattern seeking	Observing over time