	Science	Year 5
	Term 4 and 5	Topic Title: Properties and Changes of Materials

Key Question: How can materials change?

National Curriculum Objectives:

- 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.

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

Non-statutory: Smart materials
(**Teacher note:** Smart materials, called also intelligent or responsive materials, are designed materials that have one or more properties that can be significantly changed in a controlled fashion by external stimuli, such as stress, moisture, electric or magnetic fields, light, temperature, pH, or chemical compounds.)

Prior Learning:
Identify and compare the suitability of a variety of everyday materials, including wood, metal, plastic, glass, brick, rock, paper & 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. (**Y2 – Uses of everyday materials**)
Compare and group together a variety of everyday materials on the basis of whether they are attracted to a magnet, and identify some magnetic materials. (**Y3 – Forces and magnets**)
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. (**Y4 – States of matter**)

Common misconceptions:
Lots of misconceptions exist around reversible and irreversible changes, including around the permanence or impermanence of the change. There is confusion between physical/chemical changes and reversible and irreversible changes. They do not correlate simply.
Chemical changes result in a new material being formed. These are mostly irreversible.
Physical changes are often reversible but may be permanent. These do not result in new materials e.g. cutting a loaf of bread. It is still bread, but it is no longer a loaf. The shape, but not the material, has been changed.
Some children may think:
• thermal insulators keep cold in or out
• thermal insulators warm things up
• solids dissolved in liquids have vanished and so you cannot get them back
• lit candles only melt, which is a reversible change.

Knowledge: Materials have different uses depending on their properties and state (liquid, solid, gas). Properties include hardness, transparency, electrical and thermal conductivity and attraction to magnets. Some materials will dissolve in a liquid and form a solution while others are insoluble and form sediment.
Mixtures can be separated by filtering, sieving and evaporation.
Some changes to materials such as dissolving, mixing and changes of state are reversible, but changes such as burning wood, rusting and mixing vinegar with bicarbonate of soda result in the formation of new materials and these are not reversible.

Investigative skills

Fair/comparative testing	Identifying and classifying	Observations over time	Pattern seeking	Research
Independent materials recap investigation. (child led) *Which materials in my kitchen cupboard dissolve?* *Which material rusts fastest/slowest?*	*Compare and group together everyday materials on the basis of their properties.* *Understand that some materials will dissolve in liquid to form a solution.* *Can you identify and*	*How does a nail in salt water change over time?* Select measuring equipment with suitable scales to give the most precise results. Make decisions e.g. to take repeat readings, increase sample size, adjust angles in order to	*What patterns can you notice in different reactions?* *How does the amount of bicarbonate of soda, washing up liquid and vinegar affect a reaction?*	*Who is Jamie Garcia and what eco-friendly material did she invent?* *What are smart materials and how can they help us?* Talk about how scientific ideas change due to new evidence and how new discoveries change scientific understanding.

Chn decide for themselves how to select from a range of practical resources to gather evidence and carry out fair tests to answer a scientific question, recognising and controlling variables. *Which material is most reflective? (Y6 light and sight)*	*classify these reactions and changes into reversible, and irreversible, describing their similarities and differences?* Interpret data to generate simple comparative statements and illustrations based on their evidence. Identify differences, similarities or changes related to simple scientific ideas and processes. Identify causal relationships/patterns.	get accurate data. Communicate findings and record results using relevant scientific language, illustrations, diagrams, tables scatter and bar graphs.	In conclusions, chn identify causal relationships and patterns. Evaluate the choice of method used, the control of variables, and the precision and accuracy of measurements. Identify limitations that reduce the trust they have in their data. *Is there a pattern between the type/appearance of a material and its reflective properties? (Y6 light and sight)*	Report and present findings in oral and written forms.

Significant Scientists: Jamie Garcia (female)- Invention of a new fully recyclable strong plastic Becky Schroeder - fluorescence material **Spencer Silver, Arthur Fry and Alan Amron-** Post-It Notes **Sir Humphrey Davy-** Separating gases	**End point:** Can use understanding of properties to explain everyday uses of materials. Can explain what dissolving means, giving examples. Can name equipment used for filtering and sieving. Can use knowledge of liquids, gases and solids to suggest how materials can be recovered from solutions or mixtures by evaporation, filtering or sieving. Describe some simple reversible and non-reversible changes Can create a chart or table grouping/comparing everyday materials by different properties. Can use test evidence gathered about different properties. to suggest an appropriate material for a particular purpose Can group solids based on their observations when mixing them with water. Can give reasons for choice of equipment and methods to separate a given solution or mixture. Can explain the results from their investigations.
Science stories: **Itch-** Simon Mayo **Centrally heated knickers (selected poems)-** Michael Rosen	
Cross Curricular Links: **English:** Communicate findings using relevant scientific language and illustrations. **Maths:** Use standard units of measure, construct and interpret tables, charts and scatter, bar and line graphs,	**Oracy:**
Wider Reading	**Enrichment/ Science capital**
A creative approach to teaching Science-Nicky Waller Centrally heated knickers (selected poems)- Michael Rosen	Self-generated enquiry based on curiosity/interest. Thermal conductivity discussions about own coats. Flying teabag demonstration. Sustainability issues- campaigning against single use plastic and unnecessary packaging. Smart materials relating to their increasing experience of technology and products used in own lives and future.

Sequence of Learning		
Lesson	Key Question	Key learning/notes
1	What do we already know about materials	• Set up the classroom to have a wide range of objects and materials on chn's tables plus sticky labels. Can chn think of ways to describe these objects (add to labels- they should notice that there'll potentially be many labels for

	and their properties?	one material e.g foil: not stretchy, shiny, flexible, opaque)? Can they make a list of antonyms (opposite) property words- shiny/dull, flexible/rigid etc) Make a list of vocabulary as it is generated to support any struggling chn and select and add key topic vocabulary to create a properties word bank for the Science display (listen out for any misconceptions). • Play the word association game- (chn take it in turns to list scientific vocabulary associated with the word that has come before it (it is a recap of any scientific vocabulary encountered so far including states of matter, electricity, transparency, magnetism.) Play regularly to build and recap vocabulary through the unit), e.g. starter word: properties- rough, smooth, shiny, metal, magnetic, conductor, insulator, plastic etc… Add to word bank. • Provide an opportunity for independent investigations in groups. Ask chn to make suggestions of which properties of their materials could be tested to group them in different ways. (response to magnets, thermal conductivity, absorbency, stretchability (lesson guidance notes and ideas in resources) Let chn generate their own enquiry questions and feel motivated to investigate. (Put out scientific equipment to inspire their thinking: magnets, forcemeters, thermometers, measuring jugs, timers etc.) • Take photographs for WS book with post-it observations/comment notes to allow chn to feedback and discuss findings. (initial assessment of unit). • Chn to finish by explaining a new way of grouping the materials based on their tests using venn/carroll diagrams or tick charts/tables to compare properties. (Have blank scaffolds available for chn to choose and write their own criteria.)
2	Which materials in my kitchen cupboard dissolve?	• Introduce solubility as another property of materials – begin to learn terminology (soluable, insoluable, dissolve, mixture, solution). • Present chn with a range of everyday kitchen cupboard items: sugar (icing/cubed/granulated), salt, flour, coffee, instant soup, tea bag, peppercorns, jelly cubes etc What state do these items belong to? (check for misconceptions- solids. Remind some solids can be poured.) • Chn carry out an enquiry to find out more about this property by combining selected solids with water (Use and adapt dissolving experiments booklet in resources). Children to complete a comparison tick chart and record further observations under I see (appearance), I notice (changes happening), I wonder (question.) as a group. Record in books or on a group whiteboard. • Encourage chn to sort and group the solutions/mixtures into soluable and insoluable categories by comparing the solids that can be seen floating in or on the water (and so could be separated out again) or appear to have dissolved into the water. • Feedback as a class. Were there any surprises? What questions do they have? Can they suggest new solids to test or further investigation ideas using the same solids? (Record their wonders and find opportunities to carry out some more mini investigations outside of lesson time and example questions/copies of wonders for homework task) • **Don't try this at home!** Show an expanded polystyrene cup. Place it in a clear bowl of nail polish remover (containing acetone) What has happened? Explore the idea that the type of liquid can affect how a solid might dissolve. Ensure that chn don't confuse dissolving with melting or dissolving with disappearing.

3	How can we separate materials? Investigation (independent)	• Explain that some changes we make to materials can be undone or "reversed." These are called reversible changes. Can chn think of any every day examples? Explore the idea of chemical changes (reactions and creation of new materials) and then physical changes. check for misconceptions- e.g cutting a loaf of bread. It is still bread, but no longer a loaf. The shape, but not the material, has been changed. • Present fresh examples of labelled solutions and mixtures on chn's group tables including one where the solid cannot be recovered be sieving or filtration and one where magnets may be required to remove the solid from the mixture. Challenge chn to suggest ways to separate the solids from the mixtures/ liquids in their groups. • Chn use magnets, filtering, sieving (and eventually) evaporating to separate a range of mixtures. They decide on the best method for each mixture by selecting from a range of different sized sieves, filters and filter paper. • Display key vocabulary and sentence stems on the board or science display throughout the practical. Chn should set up the experiment themselves by recording which equipment they have chosen for each container and decide and note their independently chosen method of how to separate the ingredient. They should test on a trial and error basis and report on how well they achieved the outcome, including what they might do next time to adjust the process or give reasons for lack of success. (This can be done via video presentation, written in their books or on a blank group investigation template that can be photocopied for books or floor book with initialed comments from chn in the group either scribed by or for them.) • **Progress check- stop and review discoveries/successes so far. Which solution have you not recovered the solid from?** Why? Can you use your knowledge of changing states to suggest how to overcome this challenge? (encourage chn to come up with evaporation before suggesting it) How could we do this? (recall rate of evaporation work from Y4 and associate it with temperature.) Show the BBC bitesize clip- separating mixtures of materials. What key vocabulary did they hear? • Return to the experiment and choose a suitable method for evaporation to separate the salt from the water. They may do this over time using a sunny windowsill or radiator (have a class one of these to observe over time) or suggest quicker ways e.g. applying direct heat (tealight under heat stand) • Discuss everyday examples of separating mixtures by these methods and recap how these changes are **reversible**. • Observe the salt crystals left behind (if evaporation has taken place already or view fresh salt and sugar crystals using microscopes and lenses. • Launch the Explorify activity are all salt crystals the same shape? • What shape are the crystals we have observed? • Does the temperature of the water affect how much salt you can dissolve into the solution? Test as a class (Check health and safety requirements) • Think about how amount of the solute in the solution might affect the size of the crystals? Read the background Science to link to real life examples.
4	How do we keep things hot or cold?	• Look at yet another property of materials: thermal conductivity. • Compare with electrical conductivity. • Discuss what chn wear in cold weather and relate to other common objects. Use their own coat as an example. How does a coat keep us warm? Ask children to feel their coat. Does it feel warm to touch? Now put the coat on for a few moments. Do you feel warm? Now take the coat off. Is the coat warm? Discuss the process of thermal conductivity. • Carry out enquiries with insulators for warm water and cold ice cream!
5	Which changes are irreversible?	• Compare and contrast a range of reversible and irreversible changes including experiments with bicarbonate of soda to carry out pattern seeking. How does the amount of bicarbonate of soda, washing up liquid and vinegar affect a reaction? • Read Scoop a gloop: changes 2 pg 88-89 (Centrally heated knickers-copy in resources folder) What changes were explored in this poem? Explore the property language and how the materials are being changed through

		force, heat and cooling (although cooling isn't mentioned, chn should relate to their own experiences with clay.) Which changes are reversible? Irreversible? Recap definitions. • Set up an enquiry over a rusting nail enquiry over a few days using UKS2 investigation template. What do children predict will happen and can they explain why using their Science knowledge so far?
6	What changes can create new materials? Note: Safety glasses should be worn and safe distances implemented during these activities to avoid substances/debris/irritants from getting into eyes	• Discuss findings of rusty nail enquiry from lesson 5 and set up a further enquiry from wonders generated. • Introduce burning as an irreversible change. Compare this with heating. • Explain that an ancient tradition of burning money takes place during celebrations such as Chinese New Year. Encourage chn to watch what happens when paper is burned (use paper money held at a distance with tongs and a safety lighter or tea light over a tray of sand.) Discuss how when something is burned, the original material turns to ash which is now a new material. Demonstrate with the flying tea bag experiment to add extra awe and wonder and relate back to thermal conductivity (warm air rises.) • Discuss fire safety and explore further, the burning of many common materials and identify new materials formed. • Explore further chemical reactions and changes to show new substances being created including how glass windows are made BBC teach class clips. • Recap yr 4 learning that we can detect gases even though we cannot see them. Some gases are formed from chemical reactions. Allow chn to mix bicarbonate of soda and vinegar in a bottle or jam jar and stretch rubber gloves/balloons (check for allergies) over the top. Display the key vocab for children to orally present explanations (that these substances have reacted together to form a new material/gas and that the original materials can no longer (or not easily) be recovered. • Chn to form post-it predictions by generating questions before testing: e.g. Does the amount of vinegar affect the size of the inflated balloon? Can I inflate a (personal choice of different material) in the same way? If I change the amount of bicarbonate of soda what will happen to how quickly the glove inflates? Record in WS floor book.
7	How has our understanding of materials affected our lives?	• Remind chn how properties of materials are linked to uses. • Discuss **Spencer Silver** -chemist who created a new material and eventually found a practical use for it. • Research other new materials and key scientist **Jamie Garcia's** invention of a strong recyclable new plastic. • Research plastic pollution facts and write persuasive letters to supermarkets to campaign for a plastic free aisle write to manufacturers or companies such as Amazon to reduce unnecessary, wasteful packaging.
8	How can materials change?	• Discuss second rusty nail enquiry. • Look at how our knowledge and understanding of materials has changed over time and how technology and education has helped us to make certain lifestyle choices, including being more environmentally aware and careful with our use of materials (single use plastic etc.) • Introduce chn to the term Smart materials and discuss some of their properties. There will be new materials in the future that haven't been invented or discovered yet too. They could be the scientist to do it! • Complete the end of unit quiz and add any new knowledge/wonders to the Science display.