



Science

Year 4

Term 1

Topic Title: States of Matter

Key Question: What are states of matter and how do they change?

National Curriculum Objectives:

- 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 rate of evaporation with temperature.

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

National Curriculum requirement: Pupils should read and spell scientific vocabulary correctly and with confidence, using their growing word reading and spelling knowledge.

Prior Learning:

- Distinguish between an object and the material from which it is made. Identify and name a variety of everyday materials. 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 physical properties. (Y1 - Everyday materials)
- 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. (Y2 - uses of everyday materials)

Common misconceptions:

- 'solid' is another word for hard or opaque
- solids are hard/cannot break or change shape easily and are often in one piece
- substances made of tiny particles e.g sugar/sand cannot be solids
- particles in liquids are further apart than in solids and they take up more space
- when air is pumped into balloons, they become lighter
- water in different states- is all different substances
- all liquids boil at the same temperature as water (100°C)
- melting, as a change of state, is the same as dissolving
- steam is visible water vapour (only the condensing water droplets can be seen) Clouds are made of water vapour or steam
- the substance on windows etc. is condensation rather than water
- changing states of water (e.g water cycle) are irreversible
- evaporating or boiling water makes it vanish/disappear
- evaporation is when the Sun sucks up the water, or when water is absorbed into a surface/material.

Knowledge: A solid keeps its shape and has a fixed volume. A liquid has a fixed volume but changes in shape to fit the container. A liquid can be poured and keeps a level, horizontal surface. A gas fills all available space; it has no fixed shape or volume. Granular and powdery solids like sand can be confused with liquids because they can be poured, but when poured they form a heap and they do not keep a level surface when tipped. Each individual grain demonstrates the properties of a solid. Melting is a state change from solid to liquid. Freezing is a state change from liquid to solid. The freezing point of water is 0oC. Boiling is a change of state from liquid to gas that happens when a liquid is heated to a specific temperature and bubbles of the gas can be seen in the liquid. Water boils when it is heated to 100oC. **Evaporation is the same state change as boiling (liquid to gas), but happens slowly at lower temperatures and only at the surface of the liquid.** Evaporation happens more quickly if temperature is higher, the liquid is spread out or it is windy. Condensation is the change back from a gas to a liquid caused by cooling. Water at the surface of seas, rivers etc. evaporates into water vapour (a gas). This rises, cools and condenses back into a liquid forming clouds. When too much water has condensed, the water droplets in the cloud get too heavy and fall back down as rain, snow, sleet (precipitation). and drain back into rivers. This is the water cycle.

Investigative skills

Fair/comparative testing	Identifying and classifying	Observations over time	Pattern seeking	Research
<p>Does the type of liquid affect how it freezes? How does the location of a liquid affect how long it takes to evaporate? At what temperature do materials begin to melt?</p> <p>Set up practical, fair tests to answer questions, recording results in tables and graphs and using a range of practical equipment to take standard measurements of time and temp.</p> <p>Given a range of resources, chn</p>	<p>Can you group these materials and objects into solids, liquids, and gases?</p> <p>Identify differences, similarities and changes related to simple scientific ideas and processes.</p> <p>Generate comparative</p>	<p>What factors affect the rate of evaporation?</p> <p>Children take accurate measurements in ml to check the level of water that remains and record measurements at set intervals using a timer.</p> <p>Identify ways in which methods could be adapted or suggest improvements for a repeated enquiry.</p>	<p>Is there a pattern in how long it takes different types of materials to melt? How does evaporation rate change as you add more salt to your water?</p> <p>Interpret data to generate simple comparative statements based on their evidence.</p> <p>Begin to identify causal relationships.</p>	<p>Daniel Fahrenheit and Anders Celcius- temperature scales and mercury thermometer to measure higher temperatures. Research boiling points and freezing points and explore melting points in degrees Celsius (°C). How are different materials melted and used? Gain information from secondary sources to answer scientific questions.</p>

<p>decide themselves how to gather evidence to answer a question.</p> <p>Which material rusts fastest/slowest? (Y5 Properties and changes of materials)</p>	<p>statements based on their evidence. Can you identify and classify these reactions and changes into reversible, and irreversible, describing their similarities and differences? (Y5 properties and changes of materials.)</p>	<p>How does a nail in salt water change over time?</p>	<p>How does the amount of bicarbonate of soda, washing up liquid and vinegar affect a reaction? (Y5 properties and changes of materials)</p>	<p>Who is Jamie Garcia and what eco-friendly material did she invent?</p> <p>What are smart materials and how can they help us? (Y5 properties and changes of materials)</p>
<p>Significant Scientists:</p> <p>Anders Celcius (Celcius Temperature Scale)</p> <p>Daniel Fahrenheit (Fahrenheit Temperature Scale / Invention of the Thermometer)</p>		<p>End point:</p> <ul style="list-style-type: none"> • Create concept maps and diagrams, including arrows linking the key vocabulary. • Name properties of solids, liquids and gases • Give everyday examples of melting and freezing • Give everyday examples of evaporation and condensation • Describe the water cycle using correct scientific vocabulary. Give reasons to justify why something is a solid liquid or gas • Give examples of things that melt/freeze and how melting points vary. • From observations, can give melting points of some materials. • Using data, can explain what affects how quickly a solid melts • Can measure temperatures using a thermometer • Can give examples of condensation. E.g cups/windows. • From data, explain how to speed up or slow down evaporation • Present learning about the water cycle in a range of ways e.g. diagram, explanation sentences, drama, story of a water droplet 		
<p>Science stories:</p> <p>Once Upon a Raindrop: The Story of Water- James Carter</p> <p>Sticks- Diane Alber</p>				
<p>Cross Curricular Links:</p> <p>English: creative writing- journey of a water droplet.</p> <p>Maths: read a range of scales, taking measurements using standard units, construct tables and graphs.</p> <p>Geography: The water cycle</p>		<p>Oracy:</p> <p>True/False/argue</p> <p>Plus/minus/interesting What if water couldn't freeze?</p>		
<p>Wider Reading and resources</p>		<p>Enrichment</p>		
<p>Changing states video</p> <p>A creative approach to teaching Science- N Waller (p84-91)</p> <p>Active Assessment (in Science)-Naylor and Keogh</p> <p>Centrally heated knickers- Michael Rosen (physics poems)</p>		<p>Explorify fun activities</p>		

Sequence of Learning		
Lesson	Key Question	Key learning/notes
1	<p>How can we classify materials according to their state?</p> <p><i>Note: About 99 percent of your body is made up of atoms of hydrogen, carbon, nitrogen & oxygen. Matter makes up our planet and the whole universe. On Earth, all matter exists in 1 of 3 different states: solid, liquid or gas. Explain that we are going to be exploring the</i></p>	<ul style="list-style-type: none"> • Display words properties, state and particles. Elicit responses. Chn complete pre-unit quick quiz on states of matter. • Give groups a selection of solid, liquid and gas examples (pictures easiest for gas). Chn choose own criteria to sort and group. Can chn note/select any vocabulary to use to describe these materials? (provide word cards/banks/sentence stems) Take photographs/notes for WS floor book. • Properties: As a class, create a large venn diagram using the items from the sorting activity and hoops to discuss the states. Check misconceptions. • Explain trickier materials: toothpaste/ honey is a liquid even though it is viscous; a sponge is a solid, but the spaces inside it are full of air, which is gas. Bubbles are a thin film of soapy water (liquid) surrounding air (gas). • Particle Behaviour: Explain properties of S,L,Gs using info on lesson ppt. Look at how particles are arranged and how they behave in solids, liquids and gases. Organise chn into groups to demonstrate the difference between the particles in SLGs using drama and movement. Extend/check misconceptions by

	<p>properties of and the particles in materials.</p>	<p>considering materials such as sand, an unravelled ball of wool or string as these are solids despite being able to be poured/take the shape of a container. Chn draw/match solid, liquid and gas particle diagrams write explanations.</p> <ul style="list-style-type: none"> • How do we know if gas is present? Explore making gases visible e.g. squeezing sponges under water to see bubbles, and showing their effect e.g. using straws to blow objects, trees moving in the wind, breathing on surfaces. Show dancing raisins: Add 6 raisins to lemonade and observe. The bubbles stick to the rough surface of the raisins, making them float to the top of the glass. The bubbles pop on the surface of the drink, and the raisin sinks back down. This will continue until most of the carbon dioxide in the drink has escaped. • Always/sometimes/never: Water is a liquid. Use water as an example of a material that can exist in all three states at reasonable temperatures.
2	<p>Who were Daniel Fahrenheit and Anders Celcius and what were their inventions?</p>	<ul style="list-style-type: none"> • Oral starter: If I were a particle ppt complete use the ppt to recap, discuss and match properties of solids, liquids and gases. • Introduce key scientists Daniel Fahrenheit and Anders Celcius. Research facts about them and the temperature scales we use today. How and when can we use thermometers to help us work scientifically? • https://www.bbc.co.uk/bitesize/clips/z2nvcdm Use everyday examples to explain that temperature is a measure of how hot or cold something is and that it increases or decreases due to heat being transferred to or away from the object. Thermometers are the best way to measure temperature and help us to look for patterns! • Look at a line graph of temperature changes in the classroom over 24h and explain why it goes up and down. • Look at a range of different thermometers and discuss their suitability for their purpose e.g outdoor thermometers, glass thermometers, dataloggers. Teacher chn how to use a thermometer accurately and safely. • Look at a range of temperatures of different places or objects. Give children data of temperatures in a table to produce a line graph of the changes.
3	<p>What causes matter to change state? Investigation: Does the type of liquid affect how it freezes? (2 lessons) Note: You will need a variety of water/liquid to freeze. Measuring jugs Transparent plastic cups. Timer/clock <i>(Pre-boiled water should result in a mostly clear ice, salt a cloudy ice, lemonade an ice full of holes, coloured ice block with all colour pushed to centre.)</i></p>	<ul style="list-style-type: none"> • Is ice a solid, liquid or a gas? How do the particles behave? How/why might this change? • Materials change from one state to another at different temperatures. Can chn recap what temperatures water changes state? Explore how the differences in freezing and boiling points of different materials can be useful. • Ice freezing investigation- (use link for background knowledge) Working scientifically- making predictions and fair testing. Different kinds of liquid are frozen and the results observed and discussed. • Create investigation with children making predictions about what may happen when different types of liquids are frozen (compare this to the results and explore explanations next lesson.) • What if water couldn't freeze? In pairs, discuss what might be a Plus (advantage), Minus (a negative) and Interesting (generates wonder questions) point to think about the question. They could think about: How would polar bears and penguins live? How could you make a cool drink without ice? What would happen to snow? What would happen to the sea levels?!
4	<p>Investigation: Does the type of liquid affect how it freezes? (Results lesson)</p>	<ul style="list-style-type: none"> • Complete Melting Ice active assessment activity (Active assessment in Science) pg49 to answer questions about data and create some of their own. • The example results were based on simply water and how it melts. Remind children of investigation question and recap some of their predictions. What do they think they will see? Check results of the freezing liquids investigation. Keep the ice experiments somewhere visible for chn to observe the rate at which it melts while they are discussing the appearance of the ice. Give each group a stopwatch to time and a premade table to record how long each cup's ice takes to melt as an additional point to consider. • Chn record observations about the appearance of each ice cup under I see, I notice, I wonder subheadings. (Chn use equipment for close observation eg magnifying glasses/microscope to give detailed responses while ice melts.) • Share wonders. Chn complete the wonderwall with surprises and questions. What new questions could we investigate next using this experiment? What did the investigation not tell us? • Children write conclusions using their observations and scaffolded cloze procedures/word banks including the new questions they might need to

		<p>consider to learn a bit more.</p> <ul style="list-style-type: none"> Does anybody have any questions about the melting rate of their ice experiments while we were observing how the different liquids had frozen. Could the type of liquid affect its melting rate? (The salted ice should be melting quite quickly compared to the others.) Focus on salt and where this might be seen in their lives e.g salt used to grit roads in winter.
5	<p>At what temperature can a material change state?</p> <p>Investigation (Note: Alternatively, the materials in their foil cases could be placed on sealed hot water bottles containing different temperatures of water and using liquid crystal strip thermometers for safety and practical ease e.g for SEN or LA chn)</p>	<ul style="list-style-type: none"> Melting point investigations- use small amounts of materials such as wax, butter, chocolate, etc in foil cases and floated in large open bowls filled with different temperatures of water (approximately 5°C, 30°C and 40°C would work well.) Children to use scaffolded investigation template to write up predictions, results, conclusion. (Give them method.) Children make careful observations of the material beginning to melt and use dataloggers/ thermometers to take measurements of the temperature of the water when they see this happening. They will use stopwatches to record time. Record measurements using standard units in a table. Chn must then create a bar chart from their table of results. Watch Twinkl changing states video clip to recap key knowledge and compare with results from own investigations. Research: Find out about how different materials are melted and their uses. Show a clip of/or use a real example of gallium to show how some metals have low melting points and that metals can be liquids as well as solids! Can they remember another example of this? (Mercury thermometers) Relate melting points to lava and explore volcanoes as natural phenomenon.
6	<p>What is evaporation and condensation?</p> <p>(Observation over time- complete in a morning session in possible- writing activity and taking measurements over the day)</p> <p>Investigations: <i>Focus on results, fair testing and "I notice."</i></p> <p>Group investigation: What factors speed up evaporation?</p> <p>Whole class investigation: <i>How does evaporation rate change as you add more salt to your water?</i></p>	<ul style="list-style-type: none"> Look at evaporation and condensation of water as reversible changes of state. Discuss everyday examples to explore evaporation and condensation such as boiling a kettle/shower steam/windows on a cold day etc. Children read "My eternal journey" (Yr 4 overview resources) Chn set up a mini enquiry into the factors that speed up evaporation. Children decide how to set up the investigation using recycled materials (lids/tubs left out on windowsills with different covering.) Children to measure (in ml) the liquid that remains over the course of the day and record in a table. How will they ensure that it is a fair test? What will be the variable? (location) Use My eternal journey as inspiration to write their own creative paragraph to explore the journey of a water droplet in creative setting eg sea, bathroom, boiling water over a fire etc...and explain concept of evaporation/condensation. While chn are writing, set up the whole class investigation using same containers, same location but adding salt to one of the containers as a variable. Monitor and take measurements throughout the day for all investigations. Discuss with the class. Do they notice anything? Can they compare the results so far? What other factors might be affecting it? (Constantly refer back to the idea of fair testing.) At the end of the day record observations in "I notice" to explore cause/ effect. (NOT FULL INVESTIGATION WRITING) Explain/discover that evaporation happens more quickly if the temperature is higher, the liquid is spread out or it is windy. Discuss and compare results as a class to see if we have evidence in our investigations to support that idea (e.g different groups using different style containers (same amount of water)
7	<p>Where does our water come from and where does it go?</p> <p>Read once upon a raindrop: the story of water</p>	<ul style="list-style-type: none"> Read once upon a raindrop. Where does our water come from? Hunt the Science vocabulary (outdoors on painted on pebbles, leaves, made from natural resources or inside using cards and images/explanations.) chn collect all the words they can find and arrange into a possible order. Why have they arranged them in that way? (elicit prior knowledge) Use Go Noodle youtube clip water cycle (converted video in Y4 overview resources) to sing and dance the key processes in the water cycle. Activity: In partners, chn use sandwich bags to draw on the water cycle and hang on the windows to set in motion. (Chn can observe their mini-water cycles happening over the next few weeks) Alternative/additional activities: Chalk drawings on playground/giant art attack in the hall. (Take photos for books) Chn draw and label a scientific diagram of the water cycle in their own books to explain how evaporation and condensation and other processes are involved in the water cycle. Ensure chn understand that the water at the surface of the sea/river evaporates into gas. Identify different forms of water seen in weather conditions, including clouds.

		<p>(Show shaving foam cloud in a jar for a simple explanation of how clouds work)</p> <ul style="list-style-type: none">• Remind chn how important water is to plants & animals and how to conserve it. (Relate to their own efforts- turning off taps, water butts in gardens etc.)
8	<p>What are states of matter and how do they change?</p> <p><i>Assessment</i></p>	<ul style="list-style-type: none">• Children answer the key question and complete the end of unit quiz. <p><i>Multiple assessment opportunities throughout this unit mean that children do not necessarily need an additional lesson to recap however they must complete the quiz at some stage towards the end of their learning in this unit.</i></p>