Medium Term Plan
Solids, liquids and gases

P levels
Performance attainment targets (P scales) and performance descriptors are used for pupils aged 5 to 16 with special educational needs (SEN) who are working below the standard of the national curriculum tests and assessments. PSTT recognises that the national curriculum levels used in this document are no longer current. We have had so many requests to return these materials to the website that they remain in the documents as a guide for those who have used them in the past. The written statements may be useful to others as an indication of children's development. For further information about P levels see: https://www.gov.uk/government/publications/p-scales-attainment-targets-for-pupils-with-sen

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Primary Science Teaching Trust recommends that a full risk assessment is carried out before undertaking in the classroom any of the practical investigations contained in the plans.

Safety Note
PSTT advises teachers to refer to either CLEAPSS website or SSERC website for up to date health and safety information when planning practical activities for children.

Teacher's Notes: Solids, liquids and gases

Big Questions

- Where does the rain go?
- Why do snowmen disappear?
- How can water be a solid, a liquid and a gas?
- Why is the sea not a solid?
- What is the periodic table used for?
- What are all elements made from?
- Why is silver different from gold?

Learning Objectives

Pupils will have opportunities:

- To explore particles
- To explore and identify changes of state

Quick review activities

- Play simple Periodic table games.
  e.g. find hydrogen or carbon

Answers

- Rain either drains into the ground or forms puddles which may later evaporate and become water vapour.
- Snowmen disappear because when the temperature rises above 0°C, the snow melts and becomes water which drains into the ground.
- Water exists as a solid, a liquid or a gas depending on the temperature. At 0.01°C, water can exist in all three states because water is actively changing phases from solid to liquid to gas and vice versa. Liquid molecules loose a bit of energy and solidify whereas ice gains a bit of energy and melts.
- The high concentration of salt in the sea lowers its freezing point from 0°C to -2°C. As a result the ambient temperature must reach a lower point in order to freeze the sea than freshwater lakes. If the temperature is cold enough the sea does freeze.
- Elements are arranged in the periodic table so that scientists can easily see their physical and chemical properties, relationships between them and trends.
- The smallest particle of an element that retains its chemical properties is an atom.
- Silver and gold have different chemical and physical properties because they have different size atoms.

Vocabulary relevant to this topic

- State of matter – according to Newtonian laws, there are three states of matter: a solid, liquid or gas. Scientists have now identified seven including polymeric solids (jelly), plasma and Bose-Einstein condensates.
- Reversible/ physical change – one that can be undone
- Irreversible/chemical change –one that cannot be undone
- Reaction – things changing or a chemical reaction in which reacting substances are changed into products.
- Evaporation –a liquid is turned into a gas
- Condensation – Cool a gas to a liquid or a solid.
- Freeze – to change a liquid into a solid (by reducing its temperature.)
- Melting – to change a solid to a liquid (this takes place at a temperature called the melting point.)
- Boiling – when liquid starts to bubble and become a gas
- Boiling point –temperature at which liquid boils

- Particle – a tiny unit of matter is called a particle. The word 'particle' is used when the exact nature of the particle is not known or is not necessary. Particles can atoms, molecules or ions
- Element – a pure substance that cannot be split up into simpler substance. There are 118 confirmed elements (2016), 95 of which are naturally occurring, 91 are metals
- Atom – the smallest part of matter that can exist and take part in a chemical reaction. Atoms are too small to be seen with a microscope
- Proton – the small part of the atom found in the nucleus with a positive charge
- Neutron – a small part in the nucleus of an atom that has no charge (it is neutral)
- Electron – a small part of the atom that surround the nucleus on rings, with a negative charge.
- Nucleus – the central part of an atom that contains protons and neutrons.
- Heat, squashy, soft, runny, light, hard, cool, harden,

Background information about this topic

- Four states of matter observable in everyday life are solids, liquids, gases and plasma (Newton's Laws define the first three).
- 1) **Solids** keep their shape and are not easily compressed or squashed. Even a soft solid has the same volume when squashed e.g. a rubber ball just spreads out to cover a bigger area. A solid won't flow unless it has been ground into a powder.
- 2) **Liquids** have a definite volume but no fixed shape as they take the shape of the container. Liquids are difficult to compress but do flow easily.
- 3) **Gases** have no fixed shape or volume. They spread out to fill the container and flow very well. Gases are easy to compress.
- Particle theory is used to explain how things can exist in the three states. According to this theory all substances are made up of very small particles. In a solid they are arranged in regular patterns and close together – this gives the fixed shape. They vibrate but don't move far. In a liquid the particles are less tightly packed and are not arranged in a regular pattern so they can move more easily i.e. flow. The particles in a gas are not regularly arranged and are widely spaced and moving about quickly and in all directions.
- There are four main processes that you need to be aware of when teaching about change of state, these include; freezing (solidifying), melting, evaporating, condensation.
- When materials change from being a solid and become a liquid this process is described as melting - particles in a solid will absorb heat energy that is being applied, this gives the particles more kinetic energy and therefore the particles will vibrate much faster, this at first will be seen in the solid expanding. However, if enough heat is applied then particles will vibrate enough to overcome their specific place in the solid structure. This change of position will cause the particles to be pulled apart and to take on the properties of a liquid (e.g. particles have more energy, move faster and are not held together so closely.)

- When a liquid changes and becomes a gas this process is called evaporating, the process is very similar to that of melting. The particles absorb the energy from their surroundings giving an increase in the amount of kinetic energy within the particles. The increase in the amount of kinetic energy gives rise to the particles moving around much faster and with more energy. The increase in energy means the particles can overcome the forces that are holding them in the place of a liquid and will give them the properties of a gas (low density, high kinetic energy, spaced apart etc.)
- When a liquid condenses from a gas to a liquid the reverse happens as to what is seen in evaporating, instead of an increase in the amount of energy absorbed by the particles, the particles instead give out energy and they become denser, move around less and have very little kinetic energy. This loss of energy and reduced movement of particles is what brings about the change in state. When the temperature is reduced further again the particles will lose more energy still and this will bring about the particles being denser still, with little movement (vibration instead of random motion)causing the liquid to solidify or freeze and become a solid.
- Occasionally states of matter can go from a solid to a gas through the process of sublimation. This is where a solid moves to the gas phase directly without passing through the liquid phase, this is not commonly occurring for a large amount of the time, e.g. dry ice.
- Reversible reactions are reactions that when products are made they can then be broken back down into the reactants that made it to begin with.
- The periodic table is a guide to all the known elements. These elements are arranged based on their atomic number, electron configuration and chemical properties. The elements in the periodic table are placed in order of increasing atomic number (the number of protons that they contain). The rows are called periods and the columns are called groups. The periodic table that we use today was created by Dimitri Mendeleev, he developed the table so that we could easily see the relationships, properties and trends displayed and easy to use.

The periodic table can be split into two; metals and non-metals.

- Atoms are the most basic unit of matter, they consist of a nucleus at the centre (that contains protons and neutrons packed closely together), around which electrons move. These atoms are like the building blocks of everything, as each element is made up of only one type of atom.
- Elements can combine to make things such as compounds and these and the combinations they are found in can make all the things that we need in life.

Solids, liquids and gases P1-3

Objective 1: To explore particles

Descriptions of intended outcomes at different levels of attainment

- Allows themselves to be involved in the activities (P1i)
- Gives intermittent reactions to activities (P1ii)
- Accepts and engages in coactive or shared exploration of solids, liquids and gases (P2i)
- Gathers further sensory evidence by observing for a short but sustained period (P2ii)
- Explores the solids and liquids in increasingly complex ways or for longer periods of time (P3i)
- Selects or chooses the object to record with e.g. selects a solid or liquid to put in a container (P3ii)

Possible Activities:	Resources:
Experience a range of solids and liquid foods Experience 'gases' by moving air e.g. using hair dryer, fan or fan heater Help pupils encounter that things are made of smaller parts e.g. models made with Duplo or for older pupils dissemble something like a hoover	Solid articles to handle e.g. cake block, block of butter, piece of cheese, cabbage, pack of crackers etc Liquid articles to handle in containers and bowls e.g. water, squash, milk, oil, hair dryer, fan heater, fan, Hoover, duplo models

Solids, liquids and gases P1-3

Objective 1: To explore particles

Optional activities you might like to try include:	Resources:
Experience a range of household/ school solids and liquids Experience 'gases' by wafting with newspaper or different sizes of card or feeling wind outside Help pupils encounter that things are made of smaller parts e.g. simple puzzles, jigsaw mats	Solid household/ school articles to handle e.g. spoon, stapler, plate, Liquid household/ school liquids in containers and bowls to handle e.g. washing up liquid, shampoo, ink, washing liquid, after shave, newspaper, card, simple puzzles
Experience pouring powders Experience 'gases' with balloons e.g. blow up and release; pull on a bunch of inflated balloons, feel air from balloon pump Help pupils encounter that things are made of smaller parts e.g. sand castles, crushing biscuits,	

Points to Note:

Be aware of allergies to food

Pick solids that are not hollow like mugs

Solids, liquids and gases P1-3

Objective 2: To explore and identify changes of state

Descriptions of intended outcomes at different levels of attainment

- Encounters a range of sensory evidence during the activities (P1i)
- Shows an emerging awareness of activities and experiences (P1ii)
- Changes body language in a more sustained way (P2i)
- Remembers learned responses over short periods of time (P2ii)
- Purposefully uses equipment to observe a change e.g. reaches out to press button on microwave (P3i)
- Initiates interactions and activities (P3ii)

Possible Activities:	Resources:
Experience different changes of state e.g. holding an ice cube or ice pop e.g. freeze water in big container with objects in them e.g. heat a plastic disposable cup in the microwave e.g. boil water and show steam escaping e.g. hold cold mirrors or containers above steam	Ice cubes and ice pops, water, large container, objects to put in water, plastic disposable cups, kettle, cold mirrors or metal container

Optional activities you might like to try include:	Resources:
Experience changes of state using different examples e.g. make jelly and cool in the fridge use crystals and cubes e.g. melt chocolate e.g. make ice lollies or different shaped ice cubes e.g. make magic snow	Jelly crystals and cubes, hot water, chocolate to melt, plates to melt chocolate on, Magic Snow

Solids, liquids and gases P1-3

Objective 2: To explore and identify changes of state

Experience changes of state e.g. melt ice cream e.g. make meringue e.g. make ice cream http://science.howstuffworks.com/innovation/edible-innovations/ice-cream3.htm	

Points to Note:

Magic snow is available from educational suppliers or internet. It is also called Insta-snow. It expands up to 100x original size when water is added. It can be dried out to get the powder back.

Ref CLEAPSS website for safe heating of foods.

Solids, liquids and gases P4-6

Objective 1: To explore particles

Descriptions of intended outcomes at different levels of attainment

- Explores objects provided using any sensory mode (P4i)
- Shows interest in the objects and activities (P4ii)
- Responds to simple scientific questions e.g. can you show me a solid? (P5i)
- Groups objects using single criterion e.g. able to push finger through (P5ii)
- Responds to simple scientific questions that require a more detailed response than P5 e.g. can you find some other solid things in school? (P6i)
- Records using the objects provided e.g. putting solids and liquids in separate groups (P6ii)

Possible Activities:	Resources:
Explore a range of solids and liquid foods and begin to sort with help Explore 'gases' by moving air e.g. using hair dryer, fan or fan heater Explore things are made of smaller parts e.g. models made with Duplo or for older pupils dissemble something like a Hoover together	Obviously solid articles to handle e.g. cake block, block of butter, piece of cheese, cabbage, pack of crackers etc Liquid articles to handle in containers and bowls e.g. water, squash, milk, oil, hair dryer, fan heater, fan, Hoover, duplo models

Solids, liquids and gases P4-6

Objective 1: To explore particles

Optional activities you might like to try include:	Resources:
Explore a range of household/ school solids and liquids Explore 'gases' by wafting newspaper or different sizes of card or feeling wind outside perhaps holding a piece of card Explore things are made of smaller parts e.g. simple puzzles, jigsaw mats	Solid household/ school articles to handle e.g. spoon, stapler, plate, Liquid household/ school liquids in containers and bowls to handle e.g. washing up liquid, shampoo, ink, washing liquid, after shave, newspaper, card, simple puzzles
Explore pouring powders Explore 'gases' with balloons e.g. blow up and release; pull on a bunch of inflated balloons, feel air from balloon pump Explore things are made of smaller parts e.g. sand castles, crushing biscuits,	

Points to Note:

Be aware of allergies.

Solids, liquids and gases P4-6

Objective 2: To explore and identify changes of state

Descriptions of intended outcomes at different levels of attainment

- Communicates awareness of some obvious changes (P4i)
- Follows a simple step by step procedure to gather evidence (P4ii)
- Responds to and follows instructions to carry out activities involving more than one step (P5i)
- Identifies where changes have taken place (P5ii)
- Engages in experimentation using familiar equipment (P6i)
- Begins to make generalisations, predictions or connections e.g. expecting ice and chocolate to melt (P6ii)

Possible Activities:	Resources:
Explore different changes of state: e.g. melt an ice cube or ice pop and then refreeze e.g. freeze water with objects in them and then put them in different places to see which melts first e.g. decorate a plastic disposable cup and then heat in the microwave e.g. heat water using night lights or hot water bottle to show steam forming e.g. hold cold mirrors or containers above steam to show condensation Take photos of before and after Pupils could take different fruit juices (apple, orange and cherry) and use these to make their own traffic light lollies. The green juice must be added and frozen first before adding the next layer.	Ice cubes and ice pops, water, large container, objects to put in water, plastic disposable cups, kettle, cold mirrors or metal container Apple, orange and cherry juice, ice lolly moulds, access to freezer, hot water bottles, night lights, foil containers, adapted pegs to hold containers

Solids, liquids and gases P4-6

Objective 2: To explore and identify changes of state

Optional activities you might like to try include:	Resources:
Explore changes of state using different examples e.g. make jelly with crystals and cubes and cool in the fridge. e.g. melt chocolate on hot water bottles. Try different chocolates e.g. make ice lollies or different shaped ice cubes e.g. make magic snow and then leave some in a warm place to see the changes Take photos of before and after	Jelly crystals and cubes, hot water, various chocolates to melt, plates to melt chocolate on, hot water bottles, Magic Snow, water, containers,
Explore changes of state: e.g. melt ice-cream by placing in different places in seeing which melts first e.g. make meringue e.g. make ice-creamhttp://science.howstuffworks.com/innovation/edible-innovations/ice-cream3.htm . Try different types of creams to see if it makes any difference. Take photos of before and after.	

Points to Note:

Ref CLEAPSS website for safe heating of foods.
Hot water bottles are a safer way of heating/melting foods. Or pupils can use night lights in trays of sand.
Heat substances in foil containers using pegs with an extra length of wood attached as a handle.

Solids, liquids and gases P7-8

Objective 1: To explore particles

Descriptions of intended outcomes at different levels of attainment

- Makes more detailed observations (than P6)e.g. uses simple vocabulary to describe what they saw (P7i)
- Sorts materials into solids, liquids and gases with help (P7ii)
- Begins to ask some of their own questions about solids, liquids and gases (P8i)
- Records results simply on charts drawn by adults (P8ii)

Possible Activities:	Resources:
Sort a range of foods into solids and liquids. Experience pouring solids and liquids and helping them see characteristics of solids and liquids . Explore pushing 3 large plastic syringes filled with air, water and sand to compare the difference . If appropriate show pupils a simple model of particles in solids and liquids and gases using marbles in test tubes with bungs in. Ask pupils how much they move. Pupils watch what happens to raisins in a big bottle of lemonade.	Solid articles to handle e.g. cake block, block of butter, piece of cheese, cabbage, pack of crackers etc Liquid articles to handle in containers and bowls e.g. water, squash, milk, oil, jugs or beakers, 3 syringes, water, sand, raisins, large bottle of lemonade

Solids, liquids and gases P7-8

Objective 1: To explore particles

Optional activities you might like to try include:	Resources:
Sort a range of household /school items into solids and liquids Pupils use their index finger as a testing finger for solids, liquids, and gases. They ask 2 questions while using their fingers: Can you put your finger through it? Can you pour it? If you get 2 no's, then it's a solid. 2 yes's, then it's a liquid. 1 yes, 1 no, then it's a gas. Use Alka Seltzer tablets to show all three states i.e. solid tablet into liquid water in boiling tube and gas is produced which pupils can feel in they put hand over the boiling tube or put balloons over and watch them inflate or put about ¼ tablet into a film canister with lid on outside and stand back Make a class collage of solids, liquids and gases	Solid household/ school articles to handle e.g. spoon, stapler, plate, Liquid household/ school liquids in containers and bowls to handle e.g. washing up liquid, shampoo, ink, washing liquid, after shave, Alka Seltzer tablets, boiling tubes, water, balloons, film canisters, large paper, glue, magazines to find pictures of solids, liquids and gases

Ask pupils to think up actions for this poem Solid, Liquid, Gas Solid, Liquid, Gas The states of Matter just ask our class Solid has shape, Liquid takes one Gas has none Find out if gases take up space by 1) blowing into a plastic bag or a balloon with a book on top 2) crushing tissue into the end of a boiling tube and then pushing them upright into a bowl of water open end first – the tissue stays dry 3) blowing up an air bed or bike tyre	

Points to Note:

Pupils may equate solid with heavy or one big piece.

Gases can be 'poured' sometimes e.g. carbon dioxide onto a candle.

Solids, liquids and gases P7-8

Objective 2: To explore and identify changes of state

Descriptions of intended outcomes at different levels of attainment

- Makes a simple recording of findings using a camera (P7i)
- Identifies some obvious hazards e.g. hot water, mirrors (P7ii)
- Locates some of the right equipment to use for their explorations (P8i)

Possible Activities:	Resources:
Explore different changes of state e.g. melt an ice cube or ice pop and then refreeze e.g. freeze water with objects in them and then put them in different places to see which melts first e.g. Decorate a plastic disposable cup and then heat in the microwave e.g. heat water using night lights or hot water bottle to show steam forming e.g. hold cold mirrors or containers above steam to show condensation Take photos of before and after Pupils to be given a scoop of ice cream and asked to describe it. They can then eat a small spoonful of ice cream. Then leave the bowl of ice cream on the side for half an hour, now try a small spoonful of ice cream. Compare how the ice cream has changed in taste, texture and appearance. Show pupils the following video http://www.youtube.com/watch?v=_pxd56nzPl0	Ice cubes and ice pops, water, large container, objects to put in water, plastic disposable cups, kettle, cold mirrors or metal container Ice cream

Solids, liquids and gases P7-8

Objective 2: To explore and identify changes of state

Optional activities you might like to try include:	Resources:
Explore changes of state using different examples e.g. make jelly with crystals and cubes and cool in the fridge. e.g. melt chocolate on hot water bottles. Try different chocolates e.g. make ice lollies or different shaped ice cubes e.g. make magic snow and then leave some in a warm place to see the changes Take photos of before and after Pupils make jelly and put it in the fridge to set and then re-heat it to melt it again. This should reinforce the reversible reaction and allow solidifying to take place. Find out if the colour of ice makes a difference to how fast it melts – use different coloured ice pops in the same place	Jelly crystals and cubes, hot water, various chocolates to melt, plates to melt chocolate on, hot water bottles, Magic Snow, water, containers, Kettle, jelly cubes, containers to put jelly in, pan and cooker / microwave, access to fridge, different flavours of ice pops.
Experience other examples of reversible reactions. E.g. Melting chocolate , making magic snow Investigate what happens when different liquids are put into the freezer Explore changes of state e.g. melt ice cream by placing in different places in seeing which melts first e.g. make meringue e.g. make ice cream http://science.howstuffworks.com/innovation/edible-innovations/ice-cream3.htm . Try different types of creams to see if it makes any difference. Take photos of before and after	

Solids, liquids and gases P7-8

Objective 2: To explore and identify changes of state

Points to Note:

Pupils may think that all foods can change from solid to liquid and back again.

They may also think that melting is the same as dissolving and that dissolving is the same as disappearing.

Notes:
Be aware of food allergies.

Pupils need to make sure that they have sanitised hands before eating the ice cream.

Be aware of pupils using boiling water and a kettle. May need adult supervision.

Solids, liquids and gases L1-3

Objective 1: To explore particles

Descriptions of intended outcomes at different levels of attainment

- Asks simple questions stimulated by their exploration of solids, liquids and gases (L1i)
- Shows an understanding of comparative language e.g. more, same, faster, slower (L1ii)
- Communicates simple observations and differences (L1iii)
- Presents evidence in an ordered way (L2i)
- Uses simple scientific vocabulary to describe ideas and observations (L2ii)
- Sorts and groups materials into solids, liquids and gases based on observations (L2iii)
- Uses scientific vocabulary when reporting their findings (L3i)
- Describes what they have found out linking cause and effect (L3ii)
- Represents things in the real world using models (L3iii)

Possible Activities:	Resources:

Optional activities you might like to try include:	Resources:

Points to Note:

Solids, liquids and gases L1-3

Objective 2: To explore and identify changes of state

Descriptions of intended outcomes at different levels of attainment

- Draws on everyday experience to help answer questions about (L1i)
- Uses senses or simple equipment to make observations (L1ii)
- Recognises the basic features of change of state (L1iii)
- Makes suggestions about how to find things out or how to collect data (L2i)
- Spots when a simple test is unfair (L2ii)
- Says what happened in their experiments (L2iii)
- Says what they are keeping the same or changing to make a fair test (L3i)
- Makes some systematic accurate observations relevant to the question under investigation (L3ii)
- Identifies straightforward patterns in observations (L3iii)

Possible Activities:	Resources:

Optional activities you might like to try include:	Resources:

Points to Note: