ACET Junior Academies'

Scheme of Work for Science

Big Idea - Materials

Year 4 – States of matter

About this unit:

PoS – States of matter

Students take what they learnt about materials in Y1 & 2 and begin to explore them further. They are exploring the materials like scientists do, finding out what makes them change. Students will really develop these concepts in Y5, where they will be looking at chemical changes, which are permanent changes to materials. As with the electricity unit, consolidating understanding of concepts, and using key terms is key to being able to move on to study further scientific ideas.

Ice/water/steam are easy and accessible examples for the students, but try not to use the term 'water' interchangeably for 'liquid'. The students should be learning that solids can turn into liquids and then into gas – water is just an *example* of this happening.

It would be great to have a large thermometer display on the wall (this could be developed during the first lesson) for the whole of this term, so that the students can refer to it. The room temperature can be taken each day, with a moveable arrow, so that the students can see that room temperature is not exactly the same each day, but that it falls within a range. It would be useful to have the temperature of a freezer (-18°C), fridge (4°C) and boiling kettle (100°C) on there. *Don't add the freezing point/boiling point of water at this stage, as this can cause misconceptions when looking at the water cycle, when water evaporates from puddles/the sea at temperatures which are clearly below 100°C. Freezing/boiling points of water are important pieces of information, and GP students can consider this, but it's more important to consider the general concepts of changes of state with most students at this stage.*

By the end of this unit, students should be familiar with the average temperature of a room, fridge, freezer, iced water and a boiling kettle.

Unit structure

This unit is structured around seven science enquiries:

1. What's the temperature
2. What's the state?
3. Investigating temperature and change of state
4. Does Goldilocks eat ice cream?
5. Where does all the water go?
6. How many times can water change?
7. Can you keep your cool?

Links to previous and future National Curriculum units

Y1/2 – materials

- Y5 – Properties of materials & Reactions

Geography – the water cycle

<table>
<tr><th colspan="4">Enquiry 1: What's the temperature?</th></tr>
<tr><th>Links to previous learning</th><th>Scientific skills</th><th>Assessment criteria</th><th>Curricular links</th></tr>
<tr><td rowspan="3">Y1 & 2 – Materials

Properties of materials
Features of living things</td><td>EA – Pattern seeking

Asking questions
Making predictions
Observing and measuring</td><td rowspan="3">Can your children:
- Correctly estimate the position of a range of objects on a temperature scale
- State that normal room temperature is 18-20°C</td><td rowspan="3">Horizontal:
Maths – scales and continuous data

Vertical:
Y5 – Properties and changes of materials, Reactions</td></tr>
<tr><td>Key concepts:</td></tr>
<tr><td>Some things are hotter than others.
Room temperature is usually around 18 – 20°C.</td></tr>
<tr><th colspan="2">Key terms</th><th colspan="2">Common misconceptions</th></tr>
<tr><td colspan="2">Temperature, material, hotter, colder, range, estimate</td><td colspan="2"></td></tr>
<tr><th colspan="2">Suggested activities</th><th>Resources</th><th>Useful links</th></tr>
<tr><td colspan="2">Students should take the temperature of a range of substances – air in the room, tap water, teacher's coffee, air outside, water outside (pond water?), icy water. Hygiene should be noted – students should not put thermometers in their mouths, and beware of contamination if they are putting thermometers in anything edible/for human consumption.

It's really important that the students get to take the temperatures themselves, and discuss them, rather than just being given the temperatures of different places/objects. They need to be able to feel objects, and relate the temperature readings to them.

Discuss what temperature the inside of our bodies are, bath temperature, a hot sunny summers day, a cold winter's day. Students should draw a thermometer with an even, realistic scale from -20°C to 120°C , and add these temperatures on to it.

This is an excellent opportunity for maths – looking at scales. Students should be learning about continuous data – temperature scales are ideal for this.</td><td>Thermometers

A range of objects and materials of differing temperatures</td><td></td></tr>
</table>

<table>
<tr><th colspan="4">Enquiry 2: What's the state?</th></tr>
<tr><th>Links to previous learning</th><th>Scientific skills</th><th>Assessment criteria</th><th>Curricular links</th></tr>
<tr><td rowspan="2">Y3 – forces. Use the terms learnt then to identify key features here</td><td>EA – Identifying, grouping and classifying

Asking questions
Making predictions
Observing and measuring</td><td rowspan="2">Can your children:
- Identify what state of matter a material is in
- Describe the properties of the three states of matter</td><td rowspan="2">Horizontal:

Vertical:
Y5 – Properties materials, Reactions</td></tr>
<tr><td>Key concepts:
'State of matter' means whether something is solid, liquid or gas.
Solids don't change their shape, liquids form a pool at the bottom of a container, gases will escape from a container.</td></tr>
<tr><th colspan="2">Key terms</th><th colspan="2">Common misconceptions</th></tr>
<tr><td colspan="2">Matter, state, solid, liquid, gas, shape, pool, escape, push force</td><td colspan="2"></td></tr>
<tr><th colspan="2">Suggested activities</th><th>Resources</th><th>Useful links</th></tr>
<tr><td colspan="2">Identify whether a range of substances are solids, liquids or gases AT ROOM TEMPERATURE. Note the temperature of the room today – we are looking at the state of different substances at the moment, in this room. If we were somewhere really cold, like in the Arctic or a freezer, the substances may be different. This is an important concept, but only GD students are likely to access it. It's important they are aware of it, but for other students, focus on the different states of matter.

There are some substances it may be difficult to classify – it's ok to leave them as 'we're not sure' rather than force them in to one category or the other. Sand, jelly and shaving foam are good examples – GD students could discuss these. Their reasons for classification are important – what they classify them as is not.

Use adjectives to describe the properties of the different substances.
Start to look at what they have in common – what are their properties?
Demonstrate examples of these inside unsealed containers (e.g. beakers, glasses, or mugs – beware of putting boiling water in glass containers that are not heatproof) so that they are all comparable.

Solids – hold their shape, Liquids – form a pool at the bottom of the container, Gases – escape from a container.

Review forces from Y3 – If you use a push force on a solid, it moves all at once, if you use a push force on a liquid, it won't move all together, and you can't make a gas move by pushing it.</td><td>Open containers, such as beakers, glasses or mugs – try and have 3 the same

Samples of solid and liquid to put in the containers

Kettle to demonstrate gas</td><td></td></tr>
</table>

Demonstrate by putting an ice cube, cold water and boiling water in to containers. Students could make a key to identify whether something is a solid, liquid or gas – this uses skills developed in the previous two units.		

<table>
<tr><th colspan="4">Enquiry 3: Investigating temperature and change of state</th></tr>
<tr><th>Links to previous learning</th><th>Scientific skills</th><th>Assessment criteria</th><th>Curricular links</th></tr>
<tr><td rowspan="3">Y1 & 2 – Materials

Properties of materials
Features of living things</td><td>EA – Observation over time

Asking questions
Making predictions
Observing and measuring
Recording data</td><td rowspan="3">Can your children:
- State that as the temperature increases, a solid will turn into a liquid
- Read information correctly from a thermometer</td><td rowspan="3">Horizontal:
Maths - measuring, scales and continuous data

Vertical:
Y5 – Properties of materials, Reactions</td></tr>
<tr><td>Key concepts:</td></tr>
<tr><td>Ice melts as the temperature increases.
Students should become proficient at reading scales and recording the results.</td></tr>
<tr><th colspan="2">Key terms</th><th colspan="2">Common misconceptions</th></tr>
<tr><td colspan="2">Temperature, change, continuous, warmer, increase, ice, water, solid, liquid</td><td colspan="2">Students often forget that ice is water too – it's just water that has become solid.</td></tr>
<tr><th colspan="2">Suggested activities</th><th>Resources</th><th>Useful links</th></tr>
<tr><td colspan="2">Each group has a beaker with some ice cubes and cold water (the thermometers need to be immersed in the cold water to work – they won't measure the temperature of solid ice).

Add some warm water to the beaker, and record the temperature every minute. Keep taking the temperature for about 5 minutes after the ice has melted.

How long does the ice take to melt? What happens to the temperature during that time? The temperature will probably not increase steadily – see whether the students can spot any patterns in the changes.

The purpose of this lesson is to develop skills of reading a scale and timing. The students will be observing and questioning about melting.

Students should be given a table in order to record the results. They could plot a line graph of their results. GD students can decide on their own scale, but others should be given a scale in order that they can focus on the pattern of the data and what it means.

You could develop it to investigate how you could speed up/slow down the melting – although see later lessons for similar.</td><td>Beaker or similar vessel for each group.

Ice cubes, and a source of warm water

Thermometers

Stopwatches/timers

Graph paper, or grid paper.</td><td></td></tr>
</table>

Greater Depth – if we leave the water for long enough, it will get to room temperature, and then stay the same. Everything in the room is the same temperature, unless there is something making it different.		

<table>
<tr><th colspan="4">Enquiry 4: Does Goldilocks eat ice cream?</th></tr>
<tr><th>Links to previous learning</th><th>Scientific skills</th><th>Assessment criteria</th><th>Curricular links</th></tr>
<tr><td>Y1 & 2 – Materials

Properties of materials
Features of living things</td><td>EA – Observation over time

Asking questions Making predictions
Observing and measuring Recording data
Interpreting and communicating data
Key concepts:
Melting is a gradual change.
Continuous data – as time changes, the temperature changes.</td><td>Can your children:
- Describe the difference in properties as a solid warms up
- Interpret information from a line graph</td><td>Horizontal:
Maths – time as continuous data

Vertical:
Y5 – Properties of materials, Reactions</td></tr>
<tr><th colspan="2">Key terms</th><th colspan="2">Common misconceptions</th></tr>
<tr><td colspan="2">Solid, liquid, hard, soft, shape, pool, continuous,</td><td colspan="2"></td></tr>
<tr><th colspan="2">Suggested activities</th><th>Resources</th><th>Useful links</th></tr>
<tr><td colspan="2">Use the thermometer display. A freezer, and everything in it, is -18°C. The temperature of the room, and most of the objects in it, is about 20°C. If you take something out of a freezer and leave it in the room, it will warm up to 20°C.

Ice cream straight from the freezer is too hard to scoop. If you leave it out in a warm room too long, it turns to liquid.

Take ice cream from the freezer*, start a stopwatch and insert a table knife into the ice cream at the side of the container – don't push too hard. Measure how deep the knife went in. After 30 seconds, try and insert the table knife again into a different spot a comparable distance from the edge. Repeat every 30 seconds until the ice cream at the edge of the container has melted.
*make sure you are not using 'soft scoop' ice cream! You could use this as an opportunity to tell students about how scientists have made improvements to food – e.g. Mr Whippy from an ice cream van is nice and soft because scientists worked out which (edible) chemicals to add to it to stop it from freezing too hard.

Ask the students why you are testing at the edge of the container? - because this is where will be affected by the room temperature first.</td><td>A tub of ice cream, and access to a freezer
Table knife
Stopwatch
Ruler

Line graph showing potential results</td><td></td></tr>
</table>

Students can make a table of time taken, and how far the knife went in, and then a line graph of the same thing. Build on what they learnt in the last lesson, with time as continuous data. **Have an example line graph** to show the students, and ask them how far the knife went in at different times. Use this to write some guidance on how long to leave your ice cream out of the freezer before you scoop it *or* to explain that scientists can change foods to make them better, using soft scoop ice cream as an example. *If you want to expand on this topic – investigate butter straight from the fridge. Cold butter can't be spread on bread, so scientists have made spreadable butter – compare the ingredients in the two substances.*		

<table>
<tr><th colspan="4">Enquiry 5: Where does all the water go?</th></tr>
<tr><th>Links to previous learning</th><th>Scientific skills</th><th>Assessment criteria</th><th>Curricular links</th></tr>
<tr><td rowspan="3">Y1 & 2 – Materials

Properties of materials
Features of living things</td><td>EA – Problem solving

Asking questions
Making predictions
Setting up tests
Evaluating</td><td rowspan="3">Can your children:
- Define evaporation
- Describe some conditions which will make a liquid evaporate faster</td><td rowspan="3">Horizontal:

Vertical:
Y5 – Properties of materials, Reactions</td></tr>
<tr><td>Key concepts:</td></tr>
<tr><td>Evaporation is when liquid turns into gas.
Heat and air movement (wind) help to evaporate</td></tr>
<tr><th colspan="2">Key terms</th><th colspan="2">Common misconceptions</th></tr>
<tr><td colspan="2">Evaporate, liquid, gas, boil, change, faster, slower, heat, temperature, wind, air, move, dry, wet</td><td colspan="2">Try to reinforce that evaporation is the process of any liquid turning into gas, not just water.</td></tr>
<tr><th colspan="2">Suggested activities</th><th>Resources</th><th>Useful links</th></tr>
<tr><td colspan="2">What happens to the water when it rains? Some of it runs down drains – but what happens to the water that sits around in puddles?

Evaporation is when liquid turns into a gas.

Demonstrate with a boiling kettle that liquid water can turn in to gas. It's still water, and still present – it's a gas, floating in the air around us. It's so spread out we can't see it.

How fast can you get water to evaporate?

Look at pictures of washing on a line – how does the washing get dry? Look at pictures of a tumble dryer – how does the washing get dry?

In both cases, the liquid water needs to evaporate and turn into a gas. Both methods use heat, and movement/wind helps too.

Competition time – give groups of students some fabric – a small square of the same fabric each. They need to make a plan to dry the fabric. The group that gets their fabric dry the fastest are the winners.
Before they start drying the fabric, they should have a plan, with reasons for what they are doing.</td><td>Small squares of fabric
Water
Access to a heat source – lamp, sun, radiator
Hairdryers – preferably with hot/cold settings

Safety issue – wet fabric and electrical equipment</td><td></td></tr>
</table>

Students could do this in the classroom with hairdryers on different settings – or they could go outside on a sunny day, and choose a spot in the playground. Instead of a competition, they could just investigate different areas – a still sunny area, a windy sunny area, or shady still/sunny areas. At the end – evaluate – which group won? What did groups do differently? Allow each student the time to decide what they would do differently next time, to dry the material faster. If they think their method was perfect, get them to consider the best way of drying a whole load of laundry, or of drying your clothes if you fell in a stream. *GD – how do you determine which material dries fastest?* *This concept should be revisited when studying the water cycle.*		

<table>
<tr><th colspan="4">Enquiry 6: How many times can water change?</th></tr>
<tr><th>Links to previous learning</th><th>Scientific skills</th><th>Assessment criteria</th><th>Curricular links</th></tr>
<tr><td rowspan="2">Y1 & 2 – Materials

Properties of materials
Features of living things</td><td>EA – Pattern seeking

Asking questions
Making predictions
Interpreting and communicating data</td><td rowspan="2">Can your children:
- Describe what is happening as a substance is heated and cooled
- Use the terms melt, freeze, evaporate/boil, condense</td><td rowspan="2">Horizontal:
Geography – the water cycle

Vertical:
Y5 – Properties of materials, Reactions</td></tr>
<tr><td>Key concepts:
Water can keep changing between solid, liquid and gas and back again, over an over again.
There are key terms to describe the changes between states.</td></tr>
<tr><th colspan="2">Key terms</th><th colspan="2">Common misconceptions</th></tr>
<tr><td colspan="2">States of matter, ice, water, steam, solid, liquid, gas, melt, freeze, evaporate, boil, condense</td><td colspan="2">Students often think that when water boils, it ‘disappears’, or stops being water. It is still water, just really spread out in the air in tiny tiny particles, so we can’t feel it. When it is liquid, the particles are all close together, which is why we can feel it. The students don’t need to be taught this concept unless they are particularly curious – but they DO need to know that it doesn’t disappear!</td></tr>
<tr><th colspan="2">Suggested activities</th><th>Resources</th><th>Useful links</th></tr>
<tr><td colspan="2">What happens to water when you boil it? Important misconception – many students will think that the water ‘disappears’.

Boil a kettle so that the students can see the steam. Ensure they understand that it is the water that has turned into steam. We want to emphasise that the water always water, just that it changes state. Boil the kettle next to a window, or hold a mirror above it (! Safety), so the students can see the steam turning back into water.

Think of as many examples as you can of ice, liquid water and steam, e.g. icebergs, ice on top of ponds, ice cubes, snow, hail, rivers, lakes, puddles, tap water, clouds, steam from our mouths on cold days. Get the students to think of them, and find pictures of as many as possible.

Consider what happens to each of these if they get colder/warmer - when an iceberg moves from the Arctic to somewhere warmer; when there is a really cold night around a pond; when a kettle is boiled next to a cold window. Emphasise that in all of these cases, they are all made from ‘water’ – solid water, liquid water and gas water.</td><td>Kettle – near a window, or have a small mirror nearby.

Pictures and examples of ice, liquid water, steam

Examples of small quantities of ice or water for the students to use as inspiration – a small glass of water, an ice pop, an ice cube.</td><td></td></tr>
</table>

Students should draw a 'lifecycle' of ice* – revision of concepts from Y2. Important to emphasise that it is a cycle – water can go from one to the other and back again indefinitely. Also that it is controlled by temperature change – use the thermometer display to illustrate that as you go below 0°C, water will freeze, and as you heat it up, it will turn to gas. *they should choose an example of something that is ice or watery liquid – e.g. an ice pop, a glass of water, an ice cube, and describe what happens when you make it hotter or colder. *Greater depth – the boiling point of water is 100°C. This is when a whole pan of water will start turning to gas. Tiny amounts of water can become gas at lower temperatures than this.* *Also –check for quality of drawings and annotations in resources that you use. The volume of all the substances should stay the same. The faster the temperature change, the faster the change in state, but you* ***always have the same amount.*** *Avoid using resources that will lead to misconceptions.*		

<table>
<tr><td colspan="4">Enquiry 7: Can you keep your cool?</td></tr>
<tr><td>Links to previous learning</td><td>Scientific skills</td><td>Assessment criteria</td><td>Curricular links</td></tr>
<tr><td rowspan="2">Y1 & 2 – Materials

Properties of materials
Features of living things</td><td>EA – Problem solving

Asking questions
Making predictions
Recording data</td><td rowspan="2">Can your children:
- Describe how to prevent something from melting
- State that we are drawing a bar chart because our x axis has categories</td><td rowspan="2">Horizontal:
D&T
Maths – Discontinuous data

Vertical:
Y5 – Properties of materials, Reactions</td></tr>
<tr><td>Key concepts:
To keep something cold, we need to stop warm air from reaching it.
When we have discontinuous data, we draw bar charts.</td></tr>
<tr><td colspan="2">Key terms</td><td colspan="2">Common misconceptions</td></tr>
<tr><td colspan="2">State of matter, solid, ice, cold, warm, change, temperature, different, categories, data, bar chart</td><td colspan="2">Students often don't understand that melting happens because of contact with warmer air/water.</td></tr>
<tr><td colspan="2">Suggested activities</td><td>Resources</td><td>Useful links</td></tr>
<tr><td colspan="2">We have seen that leaving ice cream out on the counter allows it to melt enough to be scooped. However if you leave it out for too long it melts!

Can you design something that will keep things cold? You will be given an ice cube, which has to stay on a table in the middle of the classroom. Your mission is to design something which will stop the ice cube from melting for as long as possible.

Each group has an ice cube, and there should be a 'control' ice cube which has nothing surrounding it. Discuss all the ways in which you'll make the test fair for everyone. The result we'll be measuring is the time it takes for the ice cube to melt. The only thing which should be different is what surrounds the cube.

Students should understand that what they are aiming to do is to stop the heat from the room from reaching the ice cube. GD – the air around the ice cube will be cold. If you trap that cold air around it, and stop any extra hot air from reaching it, you'll keep it cold.

Students can draw bar charts of the results with different materials.</td><td>Ice cube per group, and a flat container (petri dish or saucer)
Thermometers
Timers
Materials for insulating</td><td></td></tr>
</table>