Temperature – the story for teachers

Why is temperature important?

Temperature is important because it is something we feel. We have to adjust our housing and clothing to it if we live in different places or at different times of year. If we get too cold or too hot we cannot survive.

But heat from the sun also evaporates water from the ground and drives the water cycle. And differences in heat from place to place are what cause winds. In fact, like life, all of the weather on earth is driven by the sun's energy.

What is temperature?

Temperature is a measure of how hot or cold something is. The 'something' can be a cup of tea, or the ground surface or the air. We measure temperature with a thermometer in degrees Celsius (°C).

When thinking about weather and climate, the first important idea is that the sun's rays heat up the earth's surfaces. And then the earth's surfaces heat up the air just above them. What we 'feel' as hot and cold depends on whether the sun's rays are heating our skin directly, and also the temperature of the air that is touching our skin. (See also 'wind chill' below.)

Why does temperature change?

Of course, the earth's surface moves, so we would expect it to be colder at night when we have spun away from the sun's rays. But some parts of the earth also get more concentrated rays than others, and at different times. This explains why it is hotter at the equator and very cold at the poles, and it also explains the seasons.

But none of this explains why it should feel cold one day and warm the next day, at the same time of day, in the same place. Remember that the earth's surfaces heat up the air just above them? The second important idea is that this air can move. If the air we are standing in has moved from a warm part of the earth, it will feel warmer. If it has moved from a cold part of the earth, it will feel colder.

Why do I feel colder when the sun goes behind a cloud?

Firstly, if you are being heated directly by the sun's rays and it goes behind a cloud, then you are left to be heated only by the air that is touching your skin, which is a less direct way of heating your skin.

Secondly, the air around you might be quite cold but you haven't noticed because the sun was heating your skin directly. Warmer air rises and colder air sinks. Therefore, cold air can get trapped, for example in a valley or in a courtyard. It might take a long time for the ground to heat it up, especially if the ground is quite cold, such as first thing in the morning. So, sometimes we can feel warm when the sun's rays are heating us directly and then suddenly realise that the air is cold when the sun goes behind a cloud.

Why do I feel warm, even when I can't see the sun?

Warm air rises. If the warm air contains water vapour, this might condense into clouds. So clouds are often found where there is warm air. Also, clouds act like a blanket over the air above the earth's surface, holding in the warmth. On the other hand, in a cloudless desert, it may be very hot during the day but very cold at night because a lot of the heat then escapes. So it is quite possible that even if the sun is blocked by clouds, your skin is in contact with quite warm air.

What is the ‘wind chill’ factor?

The temperature of the ground or pipes or other objects is affected only by the sun’s rays and the surrounding air. Wind makes no difference to these things (unless it is bringing warmer or colder air). But wind does make a difference to animals like us. The stronger the wind, the faster our skin and bodies will cool down. So, in stronger wind we ‘feel colder’ than we would if we were in the same air, with the same sun, but with no wind. That’s why hiding or standing behind someone else when it is windy feels warmer, even though you are both experiencing the same sun and the same air temperature. When you are sheltering from the wind like that, you are really sheltering from ‘wind chill’.

Temperature – middle primary

By using a range of materials and activities, we aim to focus on these outcomes and targets:

Pupil Learning Outcomes

- Temperature is the measurement of how hot or cold something is.
- It is measured using a thermometer.
- It can be measured in degrees Celsius or degrees Fahrenheit.
- The temperature increases when things are warmed by the sun's rays.
- The temperature changes as the earth moves.

Scotland: 5–14 Environmental Studies

People and place: The physical environment

- Level B: describe main weather elements and some effects on people's everyday lives.
- Level C: describe some main types of weather and climate in the world and ways in which people adapt to them.

Earth and space: materials from earth

- Level C: give some everyday uses of solids, liquids and gases.

Earth and space: changing materials

- Level B: describe how everyday materials can be changed by heating or cooling.
- Level C: describe in simple terms the changes that occur when water is heated or cooled

Skills in science – investigating

- Level B: use simple equipment and techniques to make observations and measurements.
- Level C: select and use appropriate measurement devices or make appropriate observations.

Skills in social subjects – enquiry

- Level B: process/classify simple information in a variety of ways.
- Level C: select simple techniques to process/classify straightforward information in a variety of ways.

England and Wales National Curriculum

Geography

Key Stage 1

- 1b: observe and record
- 2a: use geographical vocabulary
- 2b: use fieldwork skills
- 7a: study at a local scale
- 7b: carry out fieldwork investigations outside the classroom

Key Stage 2

- 1b: collect and record evidence
- 1c: analyse evidence and draw conclusions
- 2a: use appropriate geographical vocabulary
- 2b: use appropriate fieldwork techniques
- 3a: identify and describe what places are like
- 3d: explain why places are like they are
- 7c: carry out fieldwork investigations outside the classroom

Science – materials and their properties

Key Stage 1

- 2b: explore and describe the way some everyday materials change when they are heated or cooled

Key Stage 2

- 2a: describe changes that occur when materials are mixed
- 2b: describe changes that occur when materials are heated or cooled
- 2c: know that temperature is a measure of how hot or cold things are
- 2d: know about reversible changes including dissolving, melting, boiling, condensing, freezing and evaporating
- 2e: know about the part played by evaporation and condensation in the water cycle

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WALT

We are learning to …

Understand what temperature is and how it is measured.

Phase 1 Overview

Establish the children's prior knowledge:

- What is temperature?
- How is it measured?
- What is a thermometer?
- What has temperature got to do with the weather?
- Where does heat come from?

You can show the children the photographs of thermometers from the resources sheet (download)

Phase 2 Input

Temperature is the measurement of hotness or coldness and is measured using a thermometer. The unit of measurement used in most countries of the world is the degree Celsius, but the Fahrenheit scale of temperature is still used in one or two countries, notably the USA. Degrees Fahrenheit were commonly used in Britain up to the 1960s and are therefore found on weather maps up to that time and in older books and historical material. The table below can be used to convert the temperature from Celsius to Fahrenheit or vice versa.

Degrees Celsius (°C)	***Degrees Fahrenheit (°F)***	***Degrees Celsius (°C)***	***Degrees Fahrenheit (°F)***
-30	-22.0	16	60.8
-20	-4.0	17	62.6
-10	14.0	18	64.4
0	32.0	19	66.2
1	33.8	20	68.0
2	35.6	21	69.8
3	37.4	22	71.6
4	39.2	23	73.4
5	41.0	24	75.2
6	42.8	25	77.0
7	44.6	26	78.8
8	46.4	27	80.6
9	48.2	28	82.4
10	50.0	29	84.2
11	51.8	30	86.0
12	53.6	40	104.0
13	55.4	50	122.0
14	57.2	60	140.0
15	59.0	70	158.0

Reading a thermometer

Introduce the children to a thermometer. Practise reading it at different times each day for a week. Look at the results for any patterns.

Make a thermometer

What you need:

- a small clear plastic bottle
- water
- a clear plastic drinking straw
- plasticine
- food colouring
- a bowl of hot water

Fill the bottle to the top with water and food colouring (add enough food colouring to make the water a noticeable colour). Put the straw in the bottle but don't let it touch the bottom. Use the plasticine to seal the straw to the top of the bottle, then push the plasticine into the neck of the bottle so that the coloured water rises slightly in the straw. Heat the base of the bottle by placing it in a bowl of hot water and watch the liquid rise up through the straw.

Explanation: the thermometer works because the liquid mixture expands when warm and rises up the straw. This is what happens to mercury inside a real thermometer.

Phase 3 Process

Pin-wheel

What you need:

- a kettle
- a pin-wheel (see below on how to make one)

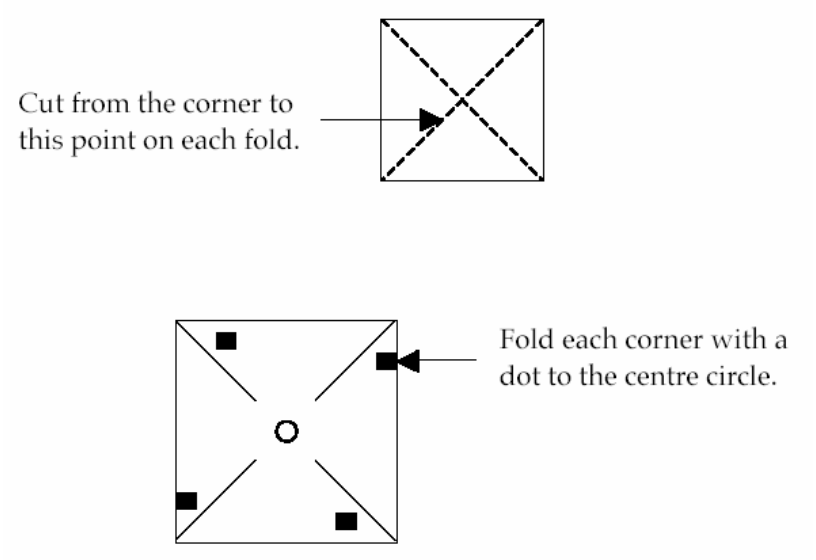
Hold the pin-wheel above the boiling kettle. The steam should turn the wheel.

Explanation: the pin-wheel turns because the heated air molecules from the steam move faster and further apart. The air then becomes lighter and rises upwards, creating an air current which moves the pin-wheel.

To make a pin-wheel you need:

- a pencil with a rubber on the end
- a pin
- a square piece of paper
- scissors

Fold the square as below:



Secure the wheel with a pin to the end of a pencil. The rubber makes it easier for the pin to pass through.

Egg in a bottle

What you need:

- a hard-boiled egg (with the shell removed)
- a glass bottle or wine carafe, with a neck that is just slightly too small for the egg to fit through
- paper
- matches or a lighter

Place the egg on top of the bottle and demonstrate that it will not fit through the opening. Light the paper and drop it into the bottle, then place the egg back on top. The paper should burn for a few seconds before the egg squeezes down through the neck of the bottle and drops into it.

This happens because of temperature. The temperature rises inside the bottle causing the air to expand and push past the egg. When the flame goes out, the air cools inside the bottle. This creates a different pressure to the outside of the bottle and the egg is forced down inside the bottle.

To get the egg out, turn the bottle upside down with the egg resting in the neck of the bottle and blow really hard. This increases the pressure inside the bottle. Move your mouth away from the bottle quickly and the egg should pop out.

Vitamin C experiment

Do chemical reactions increase/decrease when the temperature is raised?

What you need:

- two Vitamin C fizzy tablets
- two cups
- a stopwatch
- a thermometer
- a measuring jug
- cold water
- hot water

Fill one of the cups with 100 ml of cold water and the other cup with 100 ml of hot water. Record the temperature of the water in each cup. Drop the Vitamin C tablets into the water at the same time and start the stop clock. Observe which one stops fizzing first and record the time. When the other one has stopped, record the time and take the temperature once again.

- Which tablet stopped fizzing first?
- Why do you think this happened?

In higher temperatures, molecules collide more frequently and more violently which means reaction times are speeded up.

Colour experiment

When the sun shines on darker objects they reflect less heat, absorb more and therefore feel hotter to touch. Ask the children to think of a time they have walked across a stretch of grass on a hot summer's day, then stepped on to tarmac. What happened? Why do you think this happened? Does this mean that colour affects temperature?

What you need:

- three small petri dishes
- a measuring cylinder
- water
- yellow food colouring
- red food colouring
- an angle-poise lamp
- a thermometer

Fill the three dishes with the same amount of water. Add five drops of yellow food colouring to one dish and five drops of red food colouring to another dish. One dish should remain with just water to create a fair test.

Record the temperature in all three dishes. Place all three dishes underneath the lamp and turn it on. Record the temperature in each dish every 30 seconds until it remains constant. The temperature in the darker coloured pots should be slightly higher, as darker colours can absorb more heat energy.

Phase 4 Review

What is temperature?

Where does it come from?

Are chemical reaction times changed if temperature is increased/decreased? If so, why?

Does the colour of an object have an effect on its temperature in sunlight?