National Education Nature Park

Physics in the Nature Park: temperatures in school grounds

Supporting guidance

This document provides further guidance for teaching the temperatures in school grounds lesson, including discussion questions, key learning outcomes, and explanations of the relevant physics and future topic links.

Questions to encourage observation and discussion

These are suggested questions to ask learners during step 7 of the lesson.

- Are you aware of the hottest and coolest locations?
- What are the features of the hottest and coolest places?
- What variables determine surface temperature?
- Have you noticed the hot air shimmer above cars or dark asphalt? Does car colour affect it?
- Did you notice temperature variation near active air conditioning vents?
- What is the temperature near ponds?
- What is the temperature under trees?

Key learning points

These key learning points can be discussed during step 8 or referenced in future lessons.

- Temperatures vary across the school grounds on a sunny day.
- The coolest spots are usually in nature-rich areas and by open water.
- Cooler temperatures are often linked with "green and blue spaces" due to water and vegetation.
- Water evaporates from fountains, ponds and other bodies of water, cooling the surface temperature.
- Plants cool the surface temperature by transpiration. This is useful for later lessons on latent heat.
- Water is an effective thermal energy store. It needs lots of energy to change temperature. This is useful for learning about specific heat capacity later.
- Built environments and transport can get hot, but design features like light colours, reflective surfaces and plant shade can help keep them cooler. Some buildings are designed to change temperature slowly and stay cool all day.
- Air conditioning cools indoors but heats the outside air, potentially increasing demand for air conditioning and electrical power. This potentially adds to carbon dioxide emissions.
- All these phenomena are rooted in physics and offer valuable experiences to support future learning.

Relevance to everyday life

This is information can help guide the discussion in step 9 of the lesson.

Learners may already understand the dangers of heatwaves from personal experience—such as school closures in the UK on 19 July 2022 due to a heatwave or from world news coverage.

Living in hot places can pose health risks. Towns and cities get hotter than the countryside. In the UK, a heatwave is declared when night temperatures stay above 18°C. These temperatures make it hard for our bodies to cool enough for sleep. People can experience heat stress, especially the youngest and oldest. Heat stress can be fatal, and air conditioning – while helpful – contributes to climate change as most existing equipment has high energy use from burning fossil fuels.

Heat also threatens wildlife and habitats, with rising temperatures making some environments unliveable for certain species.

Identifying naturally cooling features, like nature-rich spaces, supports steps 1 and 2 of the Nature Park process and shows how physics applies to nature-based solutions to mitigate urban heating.

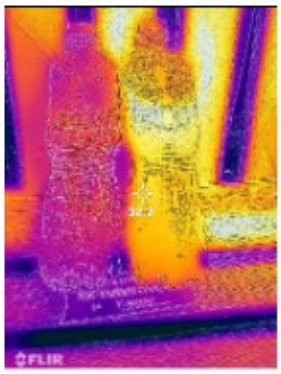
Physics helps learners understand how to make spaces more heat-resilient through nature-based solutions and smart building design. Green careers, like architecture and urban planning, are essential in making this possible.

Explanations of temperatures learners may observe

Infrared scale

In FLIR™ images (frames), white indicates the highest surface temperature and dark blue the coolest. The colour variation in FLIR™ images varies between frames.

Bottles of water



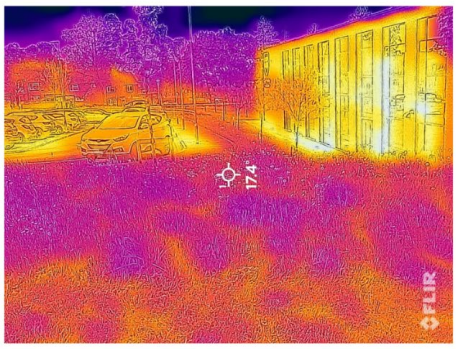
One bottle contains black dye; both started at the same temperature and were then placed in the sun for several minutes to test the effect of colour. This was to show a fair test.

Ask learners: what can you observe about the temperatures? What variable caused the difference?

Background for teachers: The black water has become hotter because the dark colour absorbs solar radiation (light and near infrared). The energy delivered by solar radiation has been transferred to the thermal store of the dyed water, which is evident by the higher temperature. Clear water transmits the solar radiation — this radiation can pass through with little absorption, and a relatively small change in temperature.

Future link: Useful for lessons on light, EM radiation, energy stores and pathways (Physics).

Car park beside school



(Co-op Academy Manchester, May morning 2024)

Learners may be able to make comparisons between a location photograph and the infrared image. White indicates the highest surface temperature in a frame and dark blue indicates the lowest.

Ask learners: how do grass length, paving, trees, and buildings affect temperature?

Background for teachers: The long grass is cooler than short grass despite the sun shining on it – there is more thermal energy loss by evaporation. Hard and dark surfaces show the greatest temperature rise because the energy delivered by sunlight is going to the thermal store.

Future link: Useful for lessons on electromagnetic radiation, latent heat and energy stores.

Temperatures on different surfaces

Learners can use an infrared thermometer to collect data (see above photograph).

Ask learners: how do the temperatures of different surfaces (in the same sunlight) compare?

Background for teachers: Surface temperature depends on factors like length of time a surface has been exposed to sunlight that day, how much solar energy is absorbed and material type beneath the surface - and its specific heat capacity. Materials like water heat slowly due to high specific heat capacity, while brick heats quickly due to a low specific heat capacity. Evaporation—and transpiration from plants—cools surfaces, linking to latent heat in future lessons.

Future link: Useful for lessons on energy stores and pathways, light and EM spectrum, latent heat (Physics) and transpiration (Biology)— linking latent heat with transpiration is important.

Green wall at school

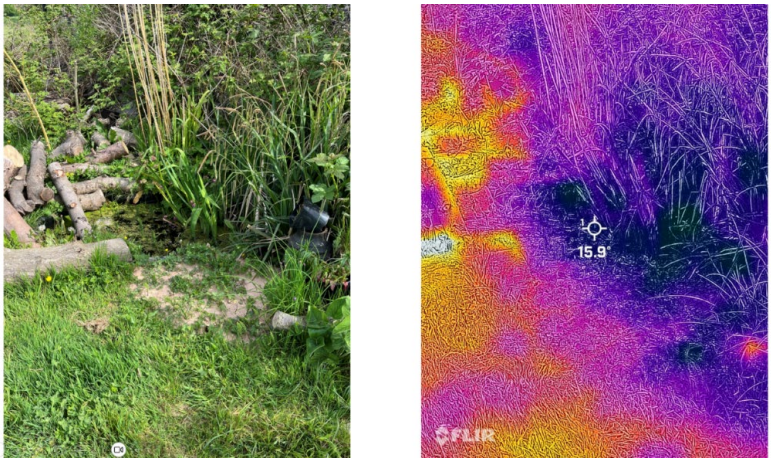
(Co-op Academy Manchester, May morning 2024)

Ask learners: what might cause the temperature differences? What is the impact of the dark cladding?

Background for teachers: The dark cladding heats up more than the light brick because the dark surface absorbs solar radiation and transfers the energy to the thermal store. The light-coloured brick reflects more of the solar radiation. This is scattered back, going off to space. Windows are cooler than the bricks — they reflect some of the sun's radiation and transmit some into the room. Plants stay cool – despite their dark colour - due to transpiration from their leaves. After the green wall was added, the classroom behind it stayed much cooler on sunny days.

Future link: Useful for lessons on energy stores and pathways, light and EM spectrum, latent heat (Physics) and transpiration (Biology).

Small pond at school



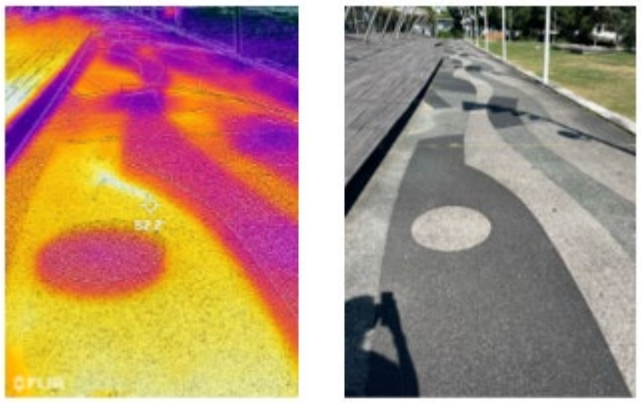
(Co-op Academy Manchester, May morning 2024)

Ask learners: what is the impact of the bodies of water on the temperature?

Background for teachers: Water heats and cools slowly due to its high specific heat capacity, staying relatively cool in the day (the temperature rises slowly) and loses its thermal energy gradually at night. In cities, water bodies help make the climate milder.

Future link: Useful for lessons on specific heat capacity (Physics).

Paved walkway



(France, 2023)

With a paved walkway like above, the only variable is colour. The impact on temperature can be shown with temperature readings. It can probably be felt by touch too.

Background for teachers: The light colour surfaces scatter (reflect diffusely) the solar radiation back to space, so it leads to little heating. The dark surfaces absorb solar radiation, and this will increase their thermal energy store. In turn they heat the surrounding air by convection and because they emit long wavelength infrared, which is absorbed by the air.

Future link: Useful for lessons on electromagnetic spectrum, light absorption and scattering reflection (Physics).

Car Park

(Co-op Academy Manchester, May morning 2024)

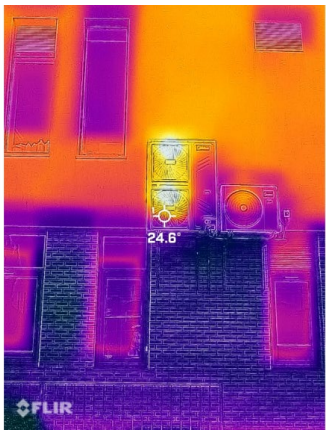
Ask learners to look at the photograph and image: what is the impact of the colour and the finish of cars on temperature?

When learners observe cars outside, ask if they notice a shimmer above the cars. Encourage them to notice the difference in temperature between different colours of cars.

Background for teachers: The darker cars are hotter than the light-coloured cars because they absorb more of the solar radiation, and this increases their thermal energy store.

Future link: Useful for lessons on light and EM spectrum and energy stores and pathways (Physics).

School wall with air conditioning



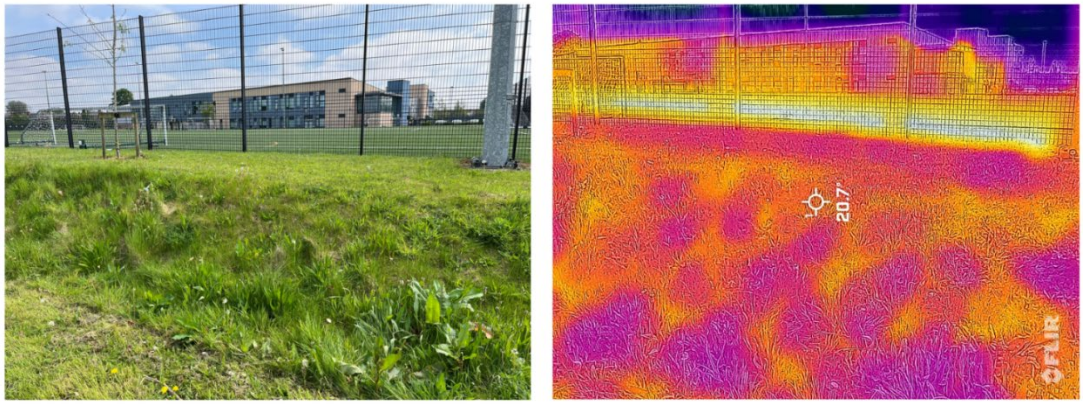
(Co-op Academy Manchester, May morning 2024)

Encourage learners to observe school buildings. In the above image learners can observe the warmest part of the image is on the air conditioning unit. If no thermal camera is available, it may be possible to estimate the temperature of the air conditioning outlet using an infrared thermometer.

Background for teachers: An air conditioning unit is like a fridge. It moves thermal energy from a cooler space (the room) to a warmer space (the exterior). It needs an electricity supply to work.

Future link: Useful for lessons on energy stores and pathways (Physics).

All weather pitch and grassed area at a school



(Co-op Academy Manchester, May morning 2024)

Background for teachers: The impact of the fake grass of an all-weather pitch is shown above. A separate image gave the temperature of the pitch as 31.3°C. This could be the starting point for a discussion about the thermal (and consequent biodiversity) impact of replacement of lawns around homes.

Future link: Useful for lessons on latent heat, evaporation (Physics) and transpiration (Biology)

National Education Nature Park

For more quality-assured learning resources visit
www.educationnaturepark.org.uk

Led by

Natural History Museum

With

RHS

Working with

esri UK
THE SCIENCE OF WHERE

Commissioned by

Department for Education

Partners

Learning through Landscapes

Manchester Metropolitan University

NBN Trust
Making data work for nature

Royal Geographical Society with IBG
Advancing geography and geographical learning

UK Centre for Ecology & Hydrology

THE ROYAL SOCIETY