

## Teaching light and heat topics through everyday experiences

This guidance brings light and heat topics to life by linking them to learners' everyday experiences around school. It explores the greenhouse effect and common misconceptions, helps discover how we can make our environments more heatwave-resilient, and highlights real-world careers where Physics helps address climate change. It does this through a focus on school grounds, where learners can come to appreciate the connection between landscape features and temperature.

It supports lessons on light transmission, absorption, and reflection; energy transfer by light; and human-driven CO<sub>2</sub> emissions and their impact on the climate.

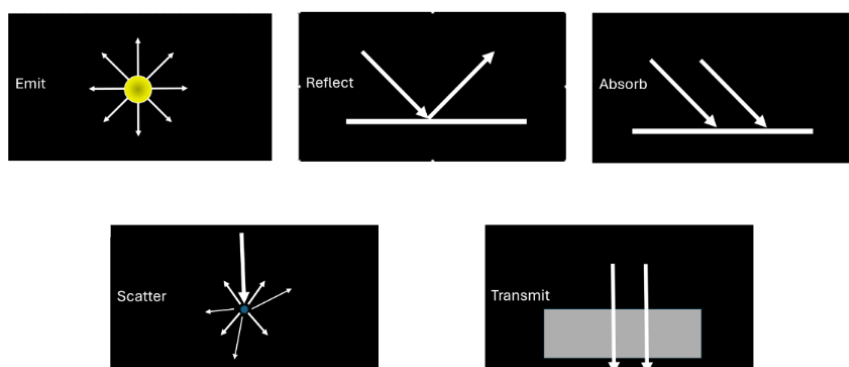
Infrared and ultraviolet can be introduced at KS3 as invisible extensions of the visible spectrum. While infrared appears in the KS4 curriculum, learners may already recognise thermal images and UV from the media.

This learning matters because the energy pathway from the Sun to Earth is essential for all life. It's how fossil fuels were formed and it powers our weather systems. This energy transfer is by electromagnetic waves—specifically light and short-wavelength infrared radiation. School grounds, accessible for all students, can make this learning relevant for everyone.

### Prior learning required

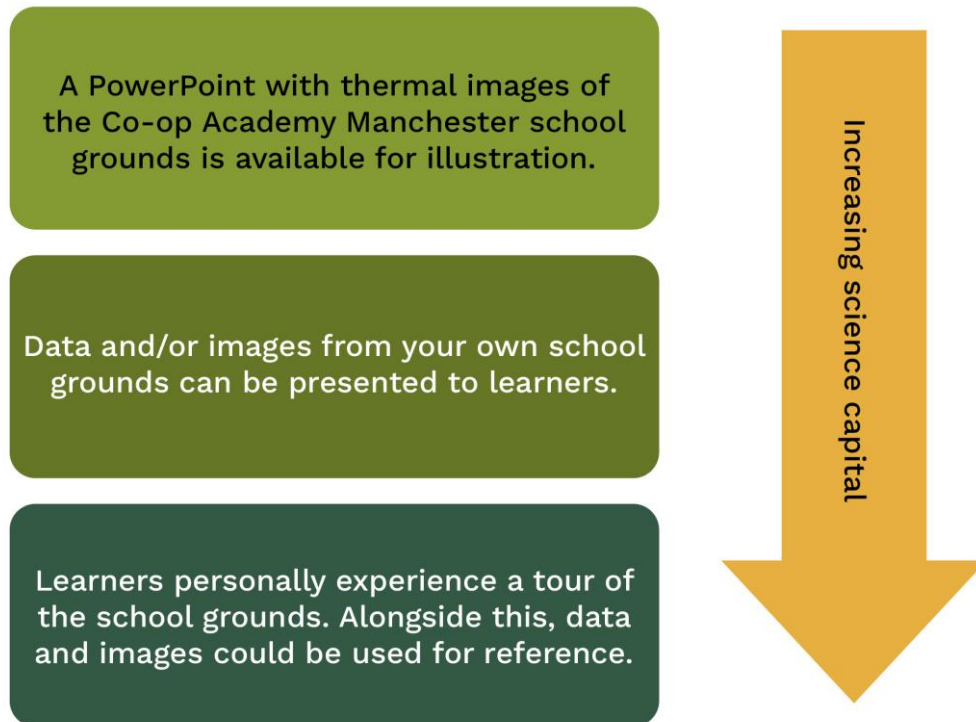
Learners should:

- have observed (or seen data or thermal images of) hot and cool areas around the school on a sunny day
- understand that the Sun transfers energy to Earth via light and ideally be aware of other spectral ranges and that the near-infrared radiation from the sun delivers a similar amount of energy to light
- know that light and infrared can interact with materials and surfaces creating heating effects (effects are summarised below and on slide three)



## Experiences of school grounds

We recommend all learners participate in the lesson Physics in the Nature Park: temperatures in school grounds prior to lessons exploring light and heating. It provides learners with real world experiences, bringing relevance to light and heat learning. The options for learners experiencing the school grounds are summarised below.



## Discussing school grounds observations

With learners, discuss the impact of surface type and colour on temperatures in the school grounds. The questions below can be used as prompts. Slides four to twelve have these questions and the photographs and thermal images from the Co-op Academy Manchester.

- How does surface colour affect temperature in sunlight, and why?
- How do dark surfaces on buildings and paving affect the surroundings during sunshine?
- What impact could dark roofs, walls or doors have on temperatures inside buildings?
- How can design and vegetation help reduce the demand for air conditioning?

## Explanation of observations learners will make



**Dark surfaces** absorb more solar radiation, thus heating up and emitting more thermal radiation, which will in turn heat the surrounding air — as shown in the thermal image. Learners might be asked: *“How do these surfaces affect the surroundings and rooms in the building?”*

**Pale surfaces** absorb less solar radiation, stay cooler, and warm the air less. Learners might be asked: *“What happens to the solar radiation when it hits pale surfaces?”* This is further explored in the background science on 'air and sunlight'.

## Surfaces and sunshine



Learners should know that solar radiation can be absorbed or reflected (often by scattering) at the surface it strikes. If learners know the 'radiation pathway', they should understand that sunlight can transfer energy from the Sun's (nuclear) store to the thermal store of the absorbing material. If sunlight is reflected, then its energy pathway is back through the atmosphere to space, and the Earth is not heated.

Learners might be asked:

- Which shirt would likely be most uncomfortable in a heatwave?
- What happens to solar radiation after it hits each T-shirt? (the terms 'absorbed' and 'reflected/ scattered' will be useful).

Use slide 13 in the presentation with learners.

## Connecting cooling solutions to global designs

Learners may consider cooling solutions by researching and discussing architecture in hot countries. For example, they may discuss traditional Mediterranean and Arabic building designs and how this helps keep buildings cool inside.

Ask learners: How can traditional Mediterranean and Arabic building designs teach us to keep buildings cool in hot sun?

Use slide 13 in the presentation with learners.

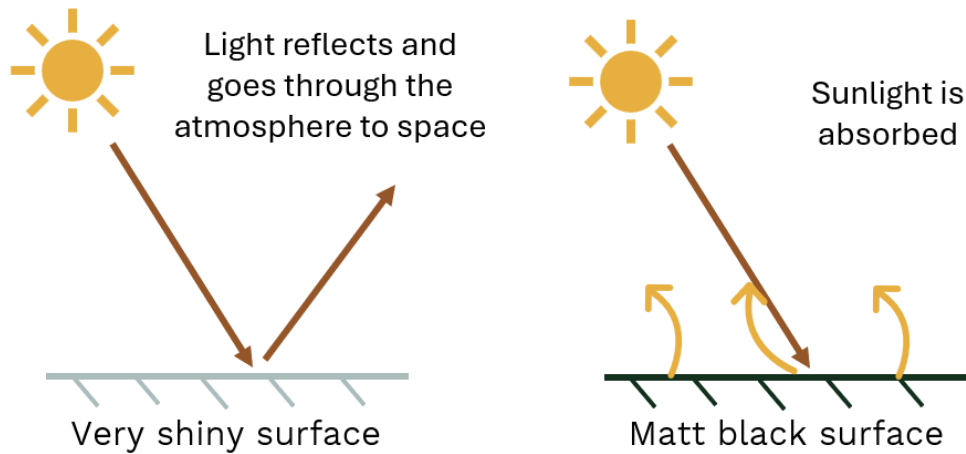
## Air and sunlight

A common misconception is that sunlight warms air. This doesn't happen. Instead, sunlight warms dark surfaces and these in turn heat the air.

Use the concept cartoon on slide 15 with learners to explore this misconception. The table explains why this happens.

Statement	Explanation
<b>Sunlight doesn't warm the air</b>	<p>Air without water droplets or smoke is nearly transparent to the sun's radiation. Sunlight that is reflected or scattered from a surface just passes back out to space through the air. Because sunlight isn't absorbed by the air, it doesn't heat it.</p> <p><i>Solar radiation is in the wrong part of the spectrum for heating the air – it has frequencies too high (or wavelengths too short) to be absorbed by air.</i></p>
<b>Sunlight warms dark surfaces, these in turn heat the air</b>	<p>Sunlight is absorbed by dark objects and the ground. This heats them, and they then heat the air. The atmosphere is warmed indirectly. This is important when explaining the greenhouse effect.</p> <p><i>Extending the thinking: Indirect heating occurs because long-wavelength infrared radiation is emitted from the Earth's surface and from objects on it. The hotter the object, the more thermal infrared radiation is emitted. This 'Earth glow' is absorbed by the greenhouse gases in the air (water vapour, carbon dioxide and methane), heating the air. The NASA graphic can help to explain this to learners. It is found on <a href="#">this webpage</a> or on slide 16 in the presentation.</i></p>

## Surface colour and heating the surroundings

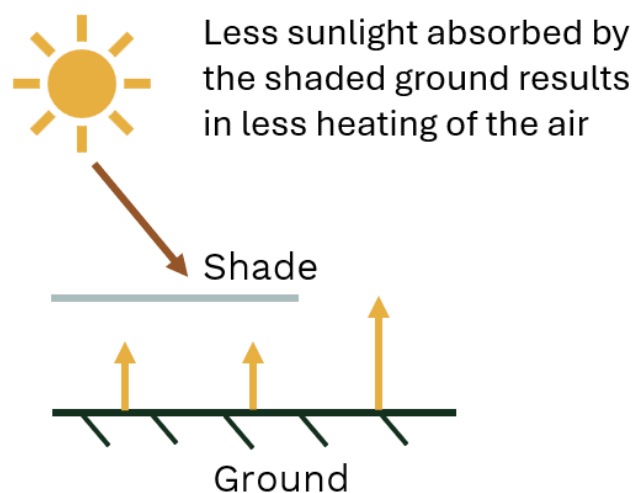


## Questions for learners about air temperature

Learners could be asked:

- Why is the temperature in the shade much lower than in full sun?
- Why is the air often cool on a sunny summer morning, even though the sun feels warm on your skin?
- Why is the hottest time of a sunny summer's day usually mid-to-late afternoon, not midday when the sun is shining most directly?

The questions are on slide 18 in the presentation. An explanation to these questions is below. It is also on slide 19 in the presentation.



The sun heats the ground. It takes a while for the ground to become warm as there is a delay between the delivery of powerful solar radiation and the heating of the air. This is because solar radiation heats the earth's surface, which in turn heats the air. This takes time.

## Glossary for teacher background

**Infrared radiation:** This is too long a wavelength for us to see. About half of the power of sunlight is delivered as invisible **near-infrared** radiation which can pass through air without being absorbed. Objects in our surroundings emit much longer wavelength **thermal infrared** radiation which is absorbed by greenhouse gases, so warming them.

**Radiation:** Involves a source with energy pathways outwards – each ray along a **radius**, as in the 'emit' graphic. Radiation can be harmless, like sound and light (mostly) are. Ionising radiation is a hazard.

**Sunlight:** Might mean just the visible light that reaches the ground from the sun but can also refer to the light and other ranges of the sun's spectrum.



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