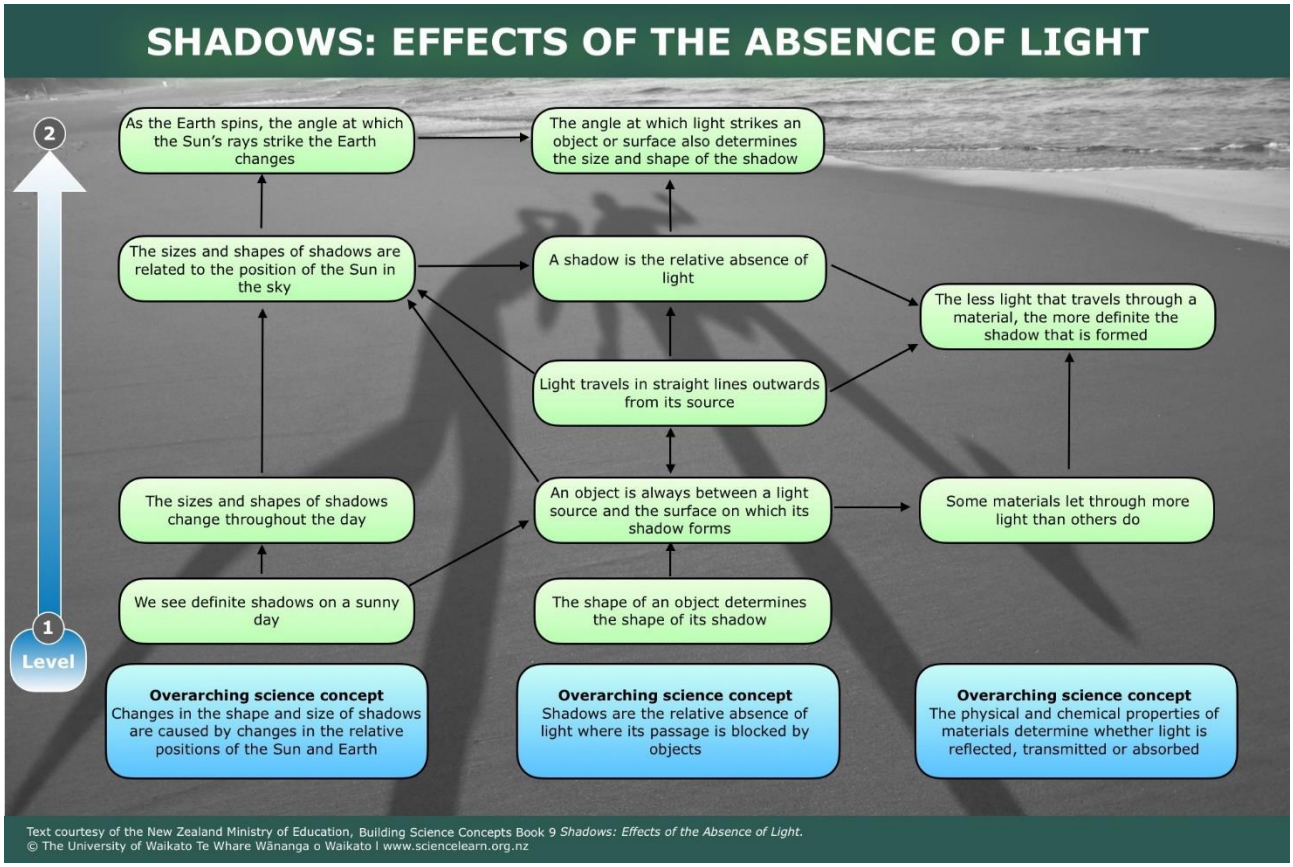
Shadows: Effects of the absence of light



This interactive explores the sequential and interlinking science concepts that underpin knowledge and understanding about light and shadows.

The concepts listed just above the overarching concepts reflect learning at New Zealand Curriculum level 1 and show how they may build in sequence to level 2. The overarching science concepts are fully developed concepts and might not be achieved until level 7 or 8.

The text is courtesy of the New Zealand Ministry of Education's *Building Science Concepts Book 9 Shadows: Effects of the Absence of Light*. The links to Hub resources provide additional background information and classroom activities that will support teachers to scaffold the development of their students' conceptual understanding about light and shadows. The images provide a means to initiate discussions, check student thinking and consolidate student understanding.

Interactive background image courtesy of Matthew Bowden.

Transcript index

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Transcript

As the Earth spins, the angle at which the Sun's rays strike the Earth changes

During the day, we perceive the Earth's spin as the Sun's apparent movement across the sky. As this occurs, the shadows cast by objects on Earth change in length because the angle at which the Sun's rays hit the object changes.

This effect becomes more pronounced in the different seasons, due to the tilt of the Earth's axis relative to the Sun. Noon shadows in winter – when the viewer's part of the Earth's surface is tilted furthest away from the Sun – are longer than noon shadows in summer.

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- Light and shadows
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- Navigating with Sun, moon and planets
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- Investigating shadows and the position of the Sun
- Investigating shadows

IMAGE: The University of Waikato Te Whare Wānanga o Waikato

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The sizes and shapes of shadows are related to the position of the Sun in the sky

During the day, we perceive the Earth's spin as the Sun's apparent movement across the sky. The Sun starts from a low arrival angle on the eastern horizon (sunrise), moves to its highest position overhead (midday) and then moves to a low departing angle on our western horizon (sunset).

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Children have difficulty grasping the idea that, although the Sun appears to move across the sky from horizon to horizon, it does not actually move. As the Earth's spin slowly turns us towards the light of the Sun and then away again, it is the viewer's position that is moving, not the Sun.

Related articles

- Light and shadows
- Alternative conceptions about light and shadows
- Navigating with Sun, moon and planets

Related images

- The Sun appearing in the east
- Eddy covariance tower (sunrise on the horizon)

Related activities

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- Investigating shadows

IMAGE: Jessie Eastland, CC BY-SA 4.0

The size and shapes of shadows change throughout the day

The shadows cast by objects on Earth change in length because the angle at which the Sun's rays hit the object changes. Large angles – when the Sun is at the horizon – make long shadows. Small angles – when the Sun is at its highest point overhead – make short shadows.

Related articles

- Light and shadows
- Alternative conceptions about light and shadows

Related images

- Long penguin shadow
- The angle of light
- Changes to a shadow's size and shape

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Related activities

- Investigating shadows
- Investigating shadows and the position of the Sun

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IMAGE: Timohummel, CC BY-S.A 3.0

We see definite shadows on a sunny day

The intensity of sunlight (or moonlight) reaching the Earth depends on atmospheric conditions. Direct sunlight creates sharper shadows than light that is diffused or scattered by clouds or atmospheric pollution, such as smog.

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Related articles

- Light and shadows

Related images

- Diffused light
- Light and water
- Shadows and shapes

Related activity

- Investigating shadows

IMAGE: Dori, CC BY-SA 3.0

The angle at which light strikes an object or surface also determines the size and shape of the shadow

The size and shape of an object's shadow changes according to:

- the size of the light source
- the position of the light source in relation to the object
- the position of the object in relation to the surface on which its shadow forms.

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Related activities

- Investigating shadows
- Investigating shadows and the position of the Sun

IMAGE: The University of Waikato Te Whare Wānanga o Waikato

A shadow is the relative absence of light

The object that casts a shadow is always between the light source and the surface on which shadow forms.

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- Light and shadows

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- The absence of light

Related activity

- Investigating shadows

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Light travels in straight lines outwards from its source

Light is produced by a source and travels outwards from the source in straight lines and all directions at 300,000 km/s.

Because we can't actually see light travelling, we depict this property in diagrams that show light travelling in straight lines called rays. These rays travel out from the source until they hit something. Depending on the properties of whatever they hit, all or some of the rays will pass through it, bounce off it or be absorbed by it.

Only a vacuum allows the completely free passage of light. Some light energy is always absorbed by any material through which light passes. Thicker samples of the same materials absorb more energy, for example, objects are seen more clearly through a thin layer of glass than through a solid glass block.

Related articles

- Light and shadows
- Light basics
- Alternative conceptions about light
- Reflection of light
- Refraction of light

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Related images

- The Sun
- The Sun's rays
- The Sun appearing in the east

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Related activity

- Investigating shadows

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An object is always between a light source and the surface on which it shadow forms

A shadow forms where light has failed to pass through an opaque object. The object that casts a shadow is always between the light source and the surface on which shadow forms.

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Related images

- Shadows and shapes
- Long penguin shadow

Related activities

- Investigating shadows
- Investigating shadows using transparent, translucent and opaque materials

IMAGE: Christopher Michel, CC BY 2.0

The shape of an object determines the shape of its shadow

The size and shape of an object's shadow changes according to:

- the size of the light source
- the position of the light source in relation to the object
- the position of the object in relation to the surface on which its shadow forms.

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The less light that travels through a material, the more definite the shadow that is formed

Shadows vary in intensity – how definite they appear. This depends on:

- the intensity of the light source and how strong the contrast between the shadow and the lit surface seems to be, which can be very subjective
- the transparency of the object – how much light it lets through
- whether there is any other material or light source between the main light source and the object, for example, clouds or smoke.

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A small source of light (for example, a small spotlight) forms a dark shadow with sharply defined edges. A physically large source of light casts a shadow that is dark in the centre but lighter and fuzzier around the outside. One reason for the blurring can be the size of the source – the larger the source, the larger the number of directions from which light can come, forming many overlapping shadows, each slightly different. You can see examples of this in the shadows formed by a fluorescent light. Diffraction (light's capacity to bend) is another reason for shadows to lighten and blur around the edges.

Both of these effects can be increased or lessened by the object's distance from the surface on which its shadow forms. The closer the object is to the surface, the darker and more definite its shadow becomes. The darkest part of a shadow is called the umbra, and the blurred, lighter parts at the edge are called the penumbra.

Related article

- Light and shadows

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- Shadows and intensity
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- Shadows and shapes

Related activities

- Investigating shadows
- Investigating shadows using transparent, translucent and opaque materials

IMAGE: VIGNERON, CC BY-S.A 3.0

Some materials let through more light than others do

Many materials fall into one of two broad groups, transparent or opaque, depending on whether light can pass directly through the material or not.

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Transparent materials let most light pass through them without noticeably scattering or absorbing it. Transparent materials are common in nature, for example, pure water, air and the crystals of many minerals. Opaque materials let no light pass through them. Many of the materials we use every day come into this category. Shadows form where light cannot pass through an opaque object.

Some materials are translucent. They allow some light through but scatter the rays so much that any object viewed through the material cannot be seen clearly. (Think of seeing something through frosted glass.) Plastics, oils, waxes and fats are usually translucent. The shadows formed by translucent materials are lighter and less definite than those formed by opaque materials.

Related article

- Light and shadows

Related images

- Opaque and translucent drink bottles
- Glass eel
- Washing in the Sun

Related activity

- Investigating shadows using transparent, translucent and opaque materials

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