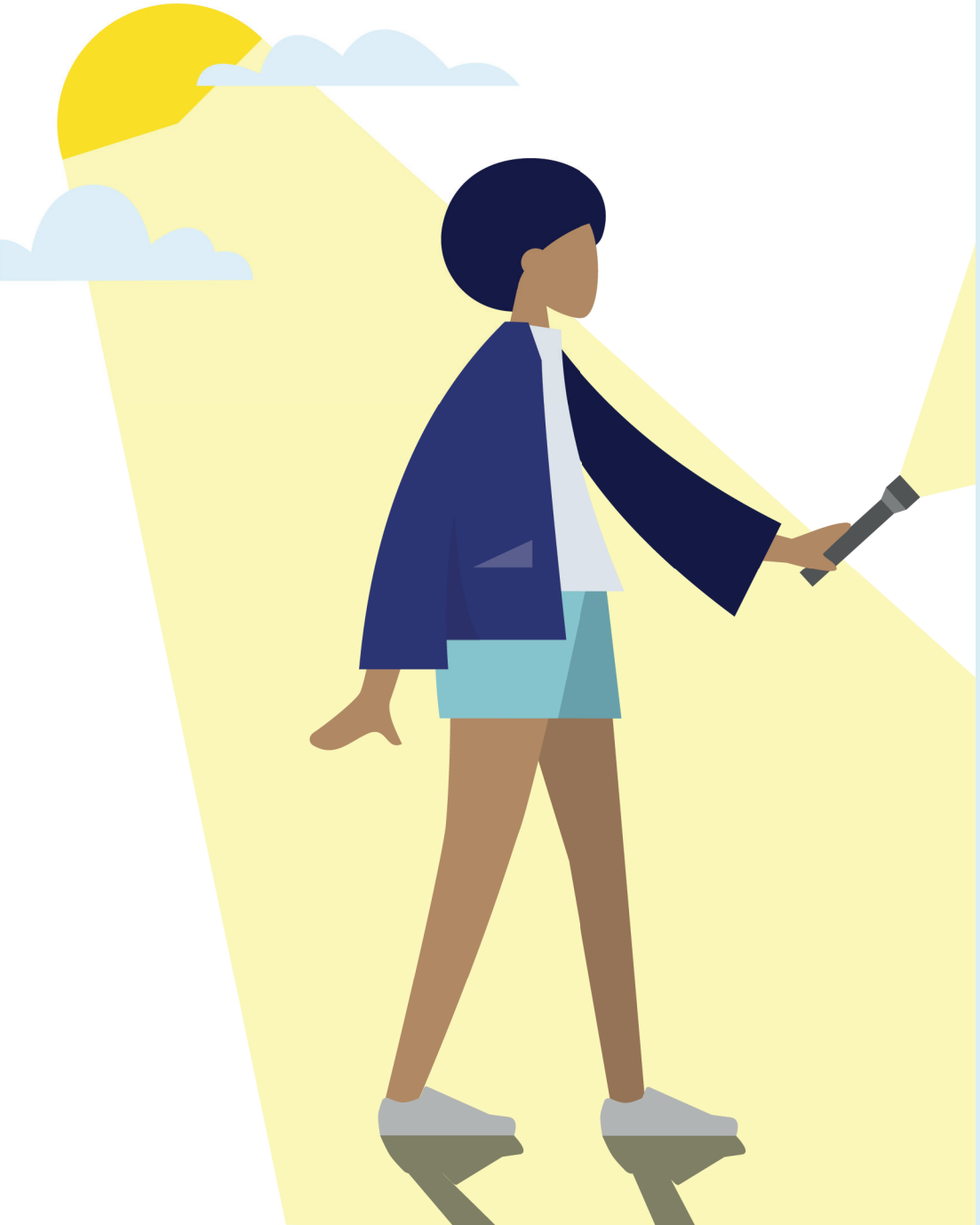


PRIMARY + STEM

Teaching Resource

ACTIVITY: Light

ACTIVITY OVERVIEW

Through this activity, students are introduced to the nature of light by exploring the different ways light interacts with matter.

Students sort and test objects made of different materials and shapes, and extend their learning to the phenomenon of day and night we experience on Earth.

SYNOPSIS

There are many ways to perceive and make meaning of our environment, but for humans, this is predominantly through what we see. Vision comes about when light from a luminous source bounces off objects and enters our eyes. What we see is shaped by how light behaves – how it travels in straight lines, how it can be absorbed, how it bounces off objects, and how it changes direction as it goes through objects.

Light energy plays a significant part in our sustainability efforts. Investment is poured into 'farming' it, with large solar panel farms and rooftop solar panels. And by rapidly replacing the highly inefficient incandescent lights with LED lights, we actively contribute to less energy usage for commercial and residential purposes. Without light, we would not have life on Earth. As an energy source, light forms the basis of all food chains through photosynthesis.

Light, and the absence of it, translates into the day and night we experience on Earth.

Our understanding of day and night on other planets, massive stars and black holes, the age of galaxies and how far away they are, and even the genesis of the Universe, would not be possible if we didn't understand how light behaves - and use that knowledge to uncover the hidden secrets all around us.

Foundation – 2

- Light and sound are produced by a range of sources and can be sensed. (VCSSU049)
- Observable changes occur in the sky and landscape; daily and seasonal changes affect everyday life. (VCSSU046)
- Explore the characteristics and properties of materials and components that are used to create designed solutions. (VCDSTC017)

Years 3 – 4

- Earth's rotation on its axis causes regular changes, including night and day (VCSSU061)
- Recognise, model, represent, and order numbers to at least 10000 (VCMNA130)
- Represent and solve problems involving multiplication using efficient mental and written strategies and appropriate digital technologies (VCMNA135)
- Convert between units of time (VCMMG167)

Year 5 – 6

- Light from a source forms shadows and can be absorbed, reflected, and refracted (VCSSU080)
- Investigate how forces or electrical energy can control movement, sound, or light in a designed product or system (VCDSTC034)

ACTIVITY, MATERIALS AND INSTRUCTIONS

Through this activity, students are introduced to the nature of light by exploring the different ways light interacts with matter. Students sort and test objects made of different materials and shapes, and extend their learning to the phenomenon of day and night we experience on Earth.

DEMONSTRATION/THEORY

Materials

A transparent object, an opaque object, a translucent object, a globe, a torch

1. Show students a transparent object, e.g. a clean and clear window pane, cling-wrap

Can students see what is on the other side of this object?

They can see the tree on the other side of the window because light from the Sun that has bounced off the tree has gone through the window and then into their eyes.

- Light bounces (reflects) off objects
- Light travels through some things
- The Sun is a source of light

2. Show students an opaque object, e.g. a large book, a wall

Can students see what is on the other side of the object? Can they see how many fingers the teacher is holding up on the other side of the book?

They cannot tell how many fingers the teacher is holding up because light from the classroom ceiling lights that has bounced off the teacher's fingers cannot go through the book. The book is a light-stopper!

- Light can be absorbed by some materials

3. Show students a translucent object, e.g. clear plastic cup

What do students think of the plastic cup? They can see something on the other side but the images are not clear. That is because the material allows only some light through.

- When light travels through some things, it can change direction

4. Shine a torch on a globe

What kind of material is the planet Earth? It's opaque because it doesn't allow light to pass through. While one side of the planet is lit and experiences day-time, the other side of the planet experiences night-time because it falls in the shadows. Shadows form because light cannot travel all around Earth to light up all parts of it.

- Light travels in straight lines

ACTIVITY

Materials

- Assorted items made from different materials from recycling bin, (at least two per child), including objects made from different types of plastic, paper, or cardboard
- Light source (sun, torch, classroom lighting)
- Word cards: lets most light through/transparent, stops light from getting through/opaque, lets some light through/translucent

Optional:

- Reflective object, e.g. mirror
- A luminous object, e.g. torch
- A curved reflective object, e.g. spoon
- A curved transparent/translucent object, e.g. plastic cup, glass jar

Instructions

1. Show students how to determine whether a material allows light through.

a) Hold an object against a source of light and observe what is on the other side of the material.

Select one object that best represents each of the following categories: transparent, translucent, and opaque.

b) Can students see what is on the other side of the object?

If students can see clearly across the material, the material lets most light through/is transparent.

- If not, the material stops light/is opaque.
- If you can see something on the other side but not clearly, the material allows only some light through/is translucent.

2. Students work in groups to sort the items into each of the three categories.

3. From their collection of items, students observe and test the materials to select:

a. objects that produce the best shadows. Opaque objects.
b. objects that students can see their reflections on. Very smooth objects. These are the kinds of surfaces that bounce (reflect) light in an orderly fashion, so that it produces an image (reflection).
c. objects that produce upside-down images. These would happen on curved surfaces, such as the inside surface of spoons.
d. objects that produce images that look bigger or smaller, or distorted.

HOW TO USE THIS ACTIVITY WITH YOUR STUDENTS

Foundation - Year 2

The connection between light-and-shadows to day-and-night on our planet is that shadows form on the one side of the Earth when the Sun is shining on other side of it. Because light travels in straight lines, it is not able to travel around Earth to light up all of it at once. This means that while one side of the planet is lit and experiences day-time, the other side of the planet experiences night-time because it falls in the shadow of the Earth.

Like the Earth, our bodies are opaque too – and this makes a for a great footpath art with our shadows! This simple extension activity requires chalk and a pavement or wall to draw on. Some students form interesting positions while others draw the outline of the shadows. It is best done during the mornings or the afternoons when the shadows formed are long. Avoid doing it when the Sun is directly above.

Years 3/4

Students are formally introduced to the concept of day-and-night on Earth as a result of our planet's rotation on its own axis. What makes this very interesting is that this same principle applies to all planets.

Just like Earth, all other planets in the solar system also rotate and experience both day and night. The length of a planetary day varies from planet to planet, depending on how quickly a planet rotates.

Given data, students could order the length of planetary days of all eight planets of the Solar System.

Then they can discuss what the numbers mean as a class, e.g. Compared to Earth. For example:

a. Which planet has the shortest/longest day? Jupiter/Venus
b. About how many months is one day on Venus? Eight months! That is equivalent to four months of day-time and four months of night-time.
c. How many hours of daytime are there on Jupiter? About five hours!
d. Which planet has a similar length of one day to Earth? Mars.
e. Convert one day on a planet into minutes/seconds.

Years 5/6

Students are formally introduced to how light behaves at this stage i.e. light travels in straight lines, reflection, and refraction. A good activity to reinforce these concepts is to use a simple coin in bowl activity. All that is required are a bowl, coin fastened to the bottom using Blu-tak, and a jug of water.

1. Fasten the coin to the bottom of a bowl with Blu-tak.
2. Ask a small group of students to stand near the bowl, and peer into it to see the coin.
   The reason why they can see the coin is because light from a source reflects from the coin and enters their eyes in straight lines.
3. Ask the students to step AWAY from the bowl and STOP moving when they no longer see the coin. They stay in this position.
   Light rays are still reflecting off the coin as before, but these light rays are no longer able to enter the eyes. The result is that students are not able to see the coin.
4. Teacher pours water slowly into the bowl. Students raise their hands when they are able to see the coin again.
   This happens because water is able to refract (change the direction) of the reflected light rays, allowing them to enter the eyes of the students.

DISCUSSION SECTION AND KEY THEMES

What is light?

Electromagnetic Spectrum

Light is a form of energy that is part of a larger group of radiations known as the electromagnetic radiation.

All energies in this group travel as waves across the Universe. Nothing that we know - including light - can travel faster than these energies.

Light from the sun takes about eight minutes to reach Earth. Our eyes are only able to detect the visible light component of the spectrum, while other organisms, such as moths and bees, are known to be able to also detect part of the UV spectrum that is invisible to us.

Light Sources

Primary light sources are objects that produce light energy from other forms of energy, e.g. the sun, fireflies, and light-bulbs.

Secondary light sources are objects that do not produce the light that they emit. Instead, they reflect light that they receive.

The moon and planets are secondary sources of light. It is a common misconception among students that the moon in luminous.

How light interacts with matter

Light can be absorbed, reflected, refracted, and/or diffracted.

These wave behaviours explain why we see everyday phenomena, such as rainbows and reflections on water.

When light interacts with an object/medium, it can do so in a combination of ways, depending upon the nature of the object. Take, for example, light interacting with a coloured drinking glass. Some of the light reflects off the surface of the drinking glass, allowing us to see it.

Some of the light gets absorbed, which allows us to perceive the colour. Only some of the light passes through the glass, which means that the glass is translucent.

Light reflects

Reflection is how we see things around us, e.g. we see objects around us when light waves reflect off the objects and enter our eyes.

The light ray that hits the surface of an object is called the incident ray. The ray of light that bounces off the objects is called the reflected ray.

How the waves are reflected depends on the texture and shape of the surface. Smooth surfaces can act as mirrors because light waves are reflected uniformly (specular reflection) and produce a shiny image.

On rougher surfaces, the waves reflect in an irregular fashion (diffuse reflection), so the object appears dull and matte.

Light is absorbed

Although most materials reflect light, some materials are better at absorbing light and converting it to another form of energy. Common examples are a matte black object that absorbs light that lands on its surface and increases in temperature as a result.

Absorption of light also explains how we perceive the colour of objects around us.

Colour

Visible light is made up of all the colours of the rainbow – red, orange, yellow, green, blue, indigo, violet.

When we see a green-coloured leaf, it is because green is the predominant colour that is not absorbed by the leaf, but reflected into our eyes. It is not because there is some inherent greenness to the leaf.

The pigments in the skin of red apples absorb all colours, except for red. This means that, in visible light, the apples reflect only red light.

This makes us perceive the apple as being red in colour.

Light changes direction

Light waves change their speed as they pass across the boundary between substances with different densities, such as air and glass. This causes them to change direction.

When light enters a medium that is denser, e.g. air to glass, the light ray slows down and changes direction.

The opposite is true when light leaves a denser medium, such as glass, into a less dense one, such as air. The light ray exiting the glass block speeds up and changes back to the original speed and direction.

Refraction explains why images can appear to be distorted when we view them, for example when we look down at our legs when we are standing in a swimming pool.

How Much Light Can Transmit Through Objects?

The amount of light that is transmitted through an object determines its transparency. If an object allows most light to pass through, the object is considered transparent. We can tell if something is transparent if we can see clearly what is on the other side.

If it doesn't allow any light to pass through, it is opaque. With opaque objects, we cannot see what is behind them.

If an object allows some light through, it is translucent.

Diffraction

Diffraction is a less obvious wave behaviour that plays a big role in our perception of light. Diffraction describes how light waves spread out when they go through small openings.

We see light diffraction at cloudy sunsets. Light has to move through very small openings between water particles in the clouds.

This results in what is often referred to as their silver lining.

1. Why can we see through some things but not others?

It depends on whether light is able to travel through an object. If it can travel through an object, e.g. a window, we say that the object is transparent. If light can be absorbed (stopped) by a book, we say that the book is opaque.

2. Why do shadows change in length throughout the day?

Shadows form when an opaque object is between a light source, e.g. the Sun, and a surface. Depending on where the light is coming from, it will affect the length and shape of the shadow. These changes are brought about as the Sun travels across the skies during the day.

3. Why do some people wear eyeglasses?

There are many reasons why people have blurred vision but it is primarily due to light rays that are not properly directed to the correct place on a person's retina. Ways to fix this include wearing eyeglasses, using contact lenses, or getting laser eye surgery.

4. Why do people wear sunglasses?

Besides looking cool, wearing proper sunglasses protect the eyes by stopping a type of light called UV rays from damaging the retina. It also blocks out excessive light and glare so that we can see more clearly.

5. Why do things look distorted when we look through a drinking glass filled with water?

When light travels through the drinking glass and water, it changes direction. This causes distorted images to form. This is like the twinkling stars we see in the night sky. Like the drinking glass and water, Earth's atmosphere is a denser medium than the vacuum of space. This causes light to change direction as it travels through the air. Movement and churning in the atmosphere adds to that and causes continual changes in the light's direction, making it appear to twinkle.

6. What are colours?

All light rays contain colour. White light that we see all around us travels in different-sized waves. These different wavelengths correspond to different colours that many of us remember with the acronym ROY G BIV. Red light has the longest wavelength (and the least energy) and violet light has the shortest wavelength (and the highest energy).

The colours of objects we see depend on which parts of the light are absorbed by the material, and which parts are reflected. The sun's rays contain all the colours of the rainbow mixed together and appear as white light. When white light strikes a white crayon, the crayon pigment doesn't absorb any colour and reflects all of it equally – the crayon appears white.

Conversely, when white light strikes a black crayon, the crayon pigment absorbs all the colours equally and reflects none of it, so it appears black to us.

A crayon appears red because the material absorbs all colours in white light except red, so it reflects red light.

7. What is light made of?

This is not an easy question to answer. Extensive experiments on light by many famed scientists from as early as the 1600s have brought us to the

understanding that light exists in two forms, depending on the conditions.

We say that light is a type of electromagnetic energy that travels in packets we refer to as photons. But it also exists as waves.

Light waves travel through a vacuum at 299,792,458 metres per second (m/s) – there is nothing we know that moves faster than light.

8. Are there days and nights on other planets?

Yes, there are, although the lengths of day-time and night-time vary considerably between them.

Day-time is experienced when one side of the planet faces the light and night-time is when that same side is in shadow.

So the answer is that it depends on how long it takes for the planets to make one complete rotation.

9. What are rainbows and how are rainbows made?

Rainbows are wondrous and colourful arcs we see in the skies after a rain when the sun is still shining, and most likely in the morning or in the late afternoon.

The colours we see in a rainbow - red, orange, yellow, green, blue, indigo, violet (ROY G. BIV) - appear when light travels through a raindrop. Each raindrop behaves like a prism, meaning that it makes the white light from the Sun change directions (refract) so much that the light splits into all the colours of the rainbow.

10. Why is water clear and milk is white?

Water is clear and transparent because it allows most light to pass through itself without much interference.

In comparison, milk is opaque and white. Milk contains fat, casein, and minerals which do not allow light to travel through (refract) milk, so the milk is not transparent like water. In fact, the particles in milk bounce back (reflect) the light that falls on it, scattering it in all directions, making the milk appear white.

OUTSIDE OR SUPPLEMENTARY READING

What Is Light | Facts About Light | DK Find Out

https://www.dkfindout.com/uk/science/light/

This site provides bite-sized information in a friendly format for children.

How Long Is One Day on Other Planets? | NASA Space Place – NASA Science for Kids

https://spaceplace.nasa.gov/days/en/

Shadow Art Created Using Garbage [8 Pics] | I Like To Waste My Time

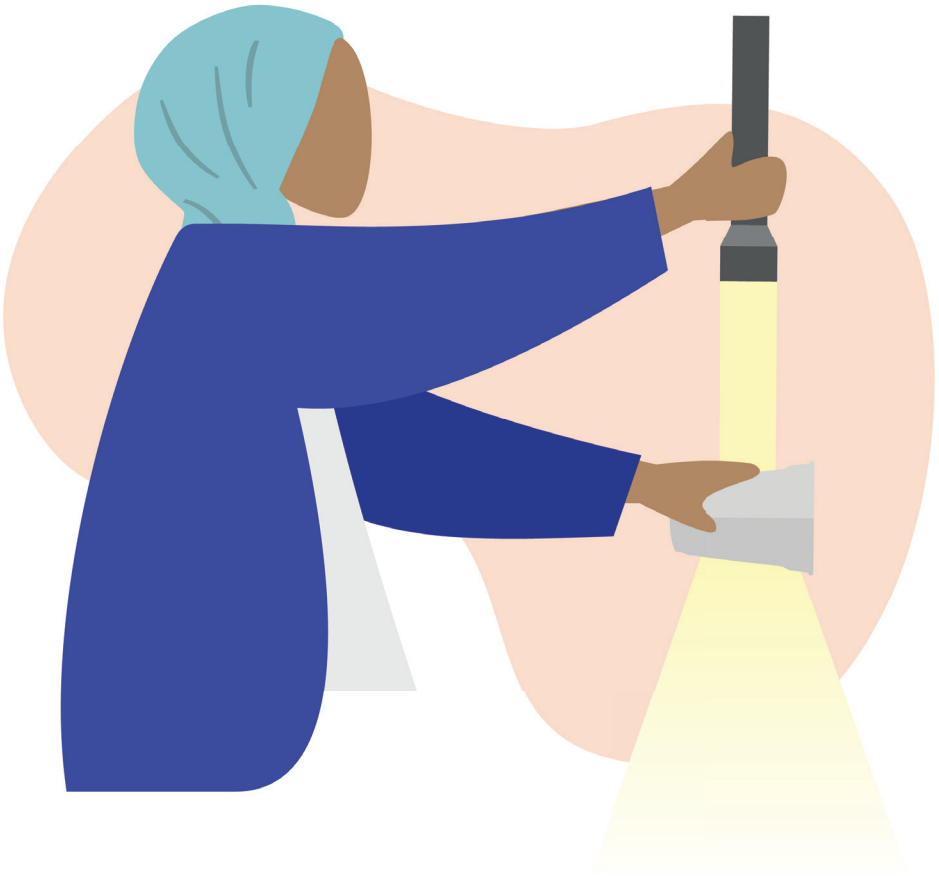
https://kidsactivitiesblog.com/137133/how-to-make-shadow-art-with-kids/

How to Make Shadow Art With Kids - Play Outside! | Kids Activities Blog

Inspiration for art that can be done by playing with shadows.

TOPIC WORDS

- Light
- Straight lines
- Bounce
- Change direction
- Absorb
- Reflect
- Refract
- Colour
- Torch
- Luminous
- Shadows



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