Reflection, Refraction and Diffraction
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- Reflection
- Refraction
- Diffraction
- Summary activities
What happens when waves hit a surface?

When electromagnetic (EM) waves hit a surface, they can be reflected, absorbed or transmitted.

How the waves behave depends on their energy and the type of material they interact with.

For example, light waves are reflected by skin, but X-rays transmitted through skin.

If electromagnetic waves are absorbed, some of their energy is transferred to the material. This usually increases the temperature of the material.
What happens when waves are reflected?

Some surfaces can reflect EM waves. Shiny surfaces are good reflectors of light waves.

When waves are reflected, some of their energy may also be absorbed by the material because surfaces do not reflect perfectly.

A mirror reflects most of the light waves that hit it.

A curved satellite dish reflects microwaves from a satellite to the receiver.

How does reflection allow us to see?
Light moves in straight lines

The formation of shadows

Light is a transverse wave. It travels in straight lines, meaning it cannot travel around objects. This results in the formation of shadows.

Select different light sources to study the types of shadow they form.
What happens when light hits a plane mirror?
The law of reflection

When a light ray hits a mirror it changes direction: the ray is reflected.

angle of incidence (i) = angle of reflection (r)

This is called the law of reflection and is true for any type of wave being reflected from a surface.
If we look into a mirror, we see an image.

What kind of image is formed in the plane mirror?

- laterally inverted
- same size as the object
- virtual.
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What is refraction?

The straw appears to be bent in the liquid. What is causing this effect?

As the light crosses the boundary between fluid and glass, it is bent, producing a distorted image.

This known as refraction.

Spear fishing has been used for centuries and is still practiced by subsistence communities.

To accurately spear the fish, fishermen learn to aim a short distance behind the fish’s image, in order to compensate for the effect of refraction.
What happens when light crosses the air-glass boundary?

- Show angles
  - Air to glass
  - Glass to air
- Ray box control
  - On
  - Off
If an incident ray enters glass at an angle, then it is refracted, and bends towards the normal.

The angle of incidence ($i$) is greater than the angle of refraction ($r$).

When the light leaves the glass, the opposite happens: it bends away from the normal.

A material which light passes through, such as glass or air, is known as a medium.
Why does light refract when it enters a different material?

Scientists often use models to explain difficult ideas. How can the behaviour of a wave as it enters a new medium be modelled using Roman soldiers and a muddy stream?

Press "play" to find out more.
### Refraction summary

#### What are the missing words about refraction?

<table>
<thead>
<tr>
<th>angle of incidence (i)</th>
<th>angle of refraction (r)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°</td>
<td>0°</td>
</tr>
<tr>
<td>10°</td>
<td>7°</td>
</tr>
<tr>
<td>20°</td>
<td>13°</td>
</tr>
<tr>
<td>30°</td>
<td>20°</td>
</tr>
</tbody>
</table>

This table shows data from an experiment where a ray of light enters a Perspex block and is refracted. It may be helpful for completing the following sentences.

1. If the ray of light hits the block parallel to the normal
In hilly areas there may not be a clear path between the transmitter and the radio, so how can a signal be received?
What is diffraction?

Diffraction is a property of all waves, which can be shown by water waves in a ripple tank. Here, the waves travel along until they reach a gap. The width of the gap is similar to the wavelength of the waves. The waves pass through the gap and spread out. This is **diffraction**.

So, when radio waves travel past an obstacle or through a narrow gap, they bend or spread out due to diffraction.
How does wavelength affect diffraction?

The amount of diffraction depends on how the wavelength compares with the size of the gap.

What happens if the wavelength is much smaller than the width of the gap?

In this case, only the edges of the wave front are diffracted.

Maximum diffraction occurs when the wavelength is similar to the gap size.
Why can I receive radio but not TV?

How does wavelength affect diffraction?

In some places, television reception is poor but radio reception is good. This is due to the diffraction of radio waves of different wavelengths. Press "play" to find out why.
When have I experienced diffraction?

How can the teacher hear the band but not see them?

Sound waves have a wavelength similar in size to the width of the doorway and so are diffracted as they pass through.

Light waves have a much shorter wavelength than sound waves and so are not diffracted by the doorway.

This means the band can be heard but not seen by the teacher in the corridor.
Diffraction problems

Telescopes have a circular aperture, where the light from distant stars enters.

Unfortunately, the light diffracts at the edge of the aperture, and a star has the spread out appearance shown at right.

Optical microscopes are also affected by diffraction. Optical microscopes pass light through a sample, which diffracts the light.

They have a limit on their resolving power (i.e. how close or how small objects may be) of about 0.5 micrometres because diffraction causes the light to spread out.
### Diffraction summary

<table>
<thead>
<tr>
<th>Statement</th>
<th>True/False</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Diffraction occurs when waves pass through a gap.</td>
<td>?</td>
</tr>
<tr>
<td>2. TV signals diffract around hills more than radio waves.</td>
<td>?</td>
</tr>
<tr>
<td>3. Diffraction occurs at the edges of telescope apertures.</td>
<td>?</td>
</tr>
<tr>
<td>4. We experience light diffraction in everyday life.</td>
<td>?</td>
</tr>
<tr>
<td>5. Diffraction is greatest when wavelength is much smaller than gap size.</td>
<td>?</td>
</tr>
<tr>
<td>6. Diffraction occurs when waves pass obstacles.</td>
<td>?</td>
</tr>
</tbody>
</table>
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Summary activities
aperture – A hole or opening through which light travels.
Anagrams relating to reflection, refraction and diffraction

How quickly can you unscramble words about

reflection
refraction &
refraction

Press "start" to begin.

start
Multiple-choice quiz

Will your performance on this quiz reflect your knowledge?

Press "start" to begin.

start