KS3 Science

Independent Learning Booklets

Light and Sound

If you have internet at home, you can use bitesize to help you with some of the activities.

Try your hardest to work through the booklets

This booklet is very similar to the year 7 Waves booklet (if you have younger brothers or sisters who have already completed it)

Sound

- Sounds are produced by **vibrations**.
- Sound travels as **waves**, which are vibrating particles.
- Sound waves are **reflected** by surfaces.

How is sound produced?

When you bang a drum its skin vibrates. The harder you bang, the bigger the vibrations. The vibrating drum skin causes nearby **air particles** to vibrate, which in turn causes other nearby air particles to vibrate. These vibrating particles make up a **sound wave**.

When electricity is passed through a speaker, the diaphragm vibrates and produces sound waves, just like a drum.

How does sound travel?

Sound waves travel at **343 m/s** through the **air** and **faster** through **liquids and solids**. The waves transfer energy from the source of the sound, e.g. a drum, to its surroundings. Your **ear** detects sound waves when vibrating air particles cause your **ear drum to vibrate**. The bigger the vibrations the louder the sound.

Reflection of sound

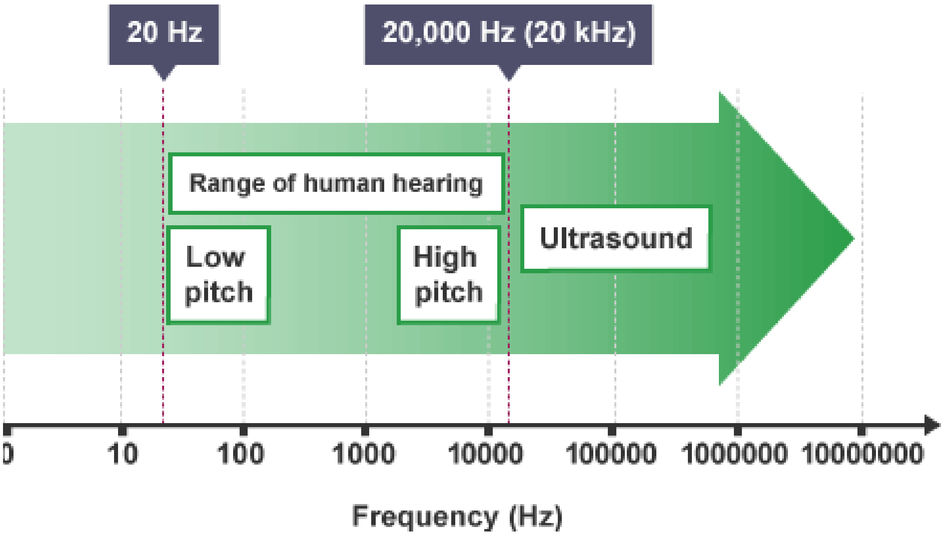
Surfaces reflect sound waves:

Hard surfaces reflect sound **well**, making **echoes**.

Soft surfaces, like curtains and carpets, reflect **very little** sound. They **absorb** the sound instead, so there are no echoes.

Ultrasound

The frequency of sound waves is measured in hertz, which has the symbol Hz. The bigger the number, the greater the frequency and the higher the pitch of the sound. Human beings can generally hear sounds as low as 20 Hz and as high as 20,000 Hz (20 kHz).

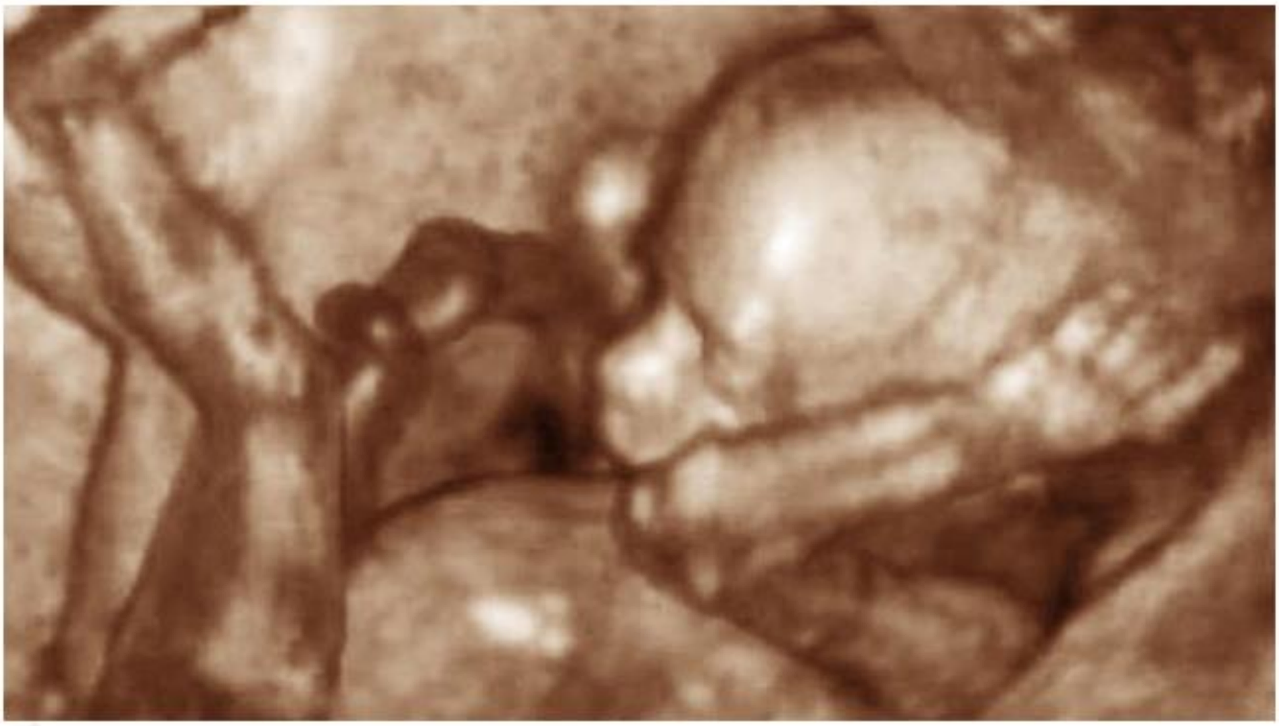


The normal range of human hearing and ultrasound

High pitched

Sound with a frequency of more than 20,000 Hz is called **ultrasound**. It is too high pitched for humans to hear, but other animals (such as dogs, cats and bats) can hear ultrasound.

Ultrasound has many applications in medicine, including ultrasound scans to check on the health of unborn babies.



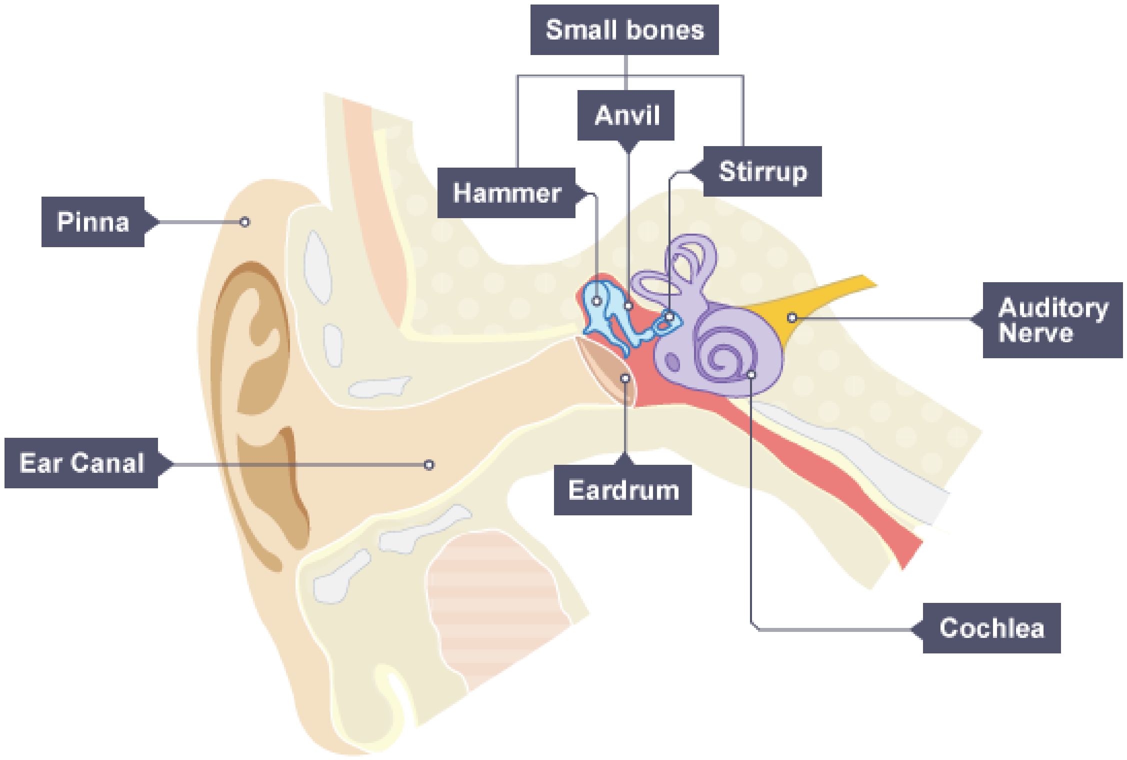
An ultrasound image of an unborn baby

Bell jar experiment - https://www.youtube.com/watch?v=hIOqX4uJtYY

Detecting sound

Ears

We can detect sound using our ears. An ear has an eardrum inside, connected to three small bones. The vibrations in the air make the eardrum vibrate, and these vibrations are passed through the three small bones (called ossicles) to a spiral structure called the cochlea. Signals are passed from the cochlea to the brain through the auditory nerve, and our brain interprets these signals as sound.



Activities:

Task	Description
1	Write a simple description of how sound is made
2	Write a description and draw a picture examples of musical instruments labelled appropriately stating how sound travels
3	Research the uses of sound in medical practice
4	Research the uses of sound in Marine studies
5	Watch the 2 minute video and write down what happens Bell Jar experiment
6	Sketch the diagram of the ear- label it and use the information to explain what happens at each part
7	Create a revision poster on everything you know about sound and hearing.

Light

How light travels

Light travels as waves. These are **transverse** waves, like the ripples in a tank of water. The direction of vibration in the waves is at 90° to the direction that the light travels.

Light travels in straight lines, so if you have to represent a ray of light in a drawing, always use a ruler.

Unlike sound waves, light waves can travel through a **vacuum** (empty space). They do not need a substance to travel through, but they can travel through **transparent** and **translucent** substances. The table summarises some similarities and differences between light waves and sound waves:

	Light waves	Sound waves
Type of wave	Transverse	Longitudinal
Can they travel through matter (solids, liquids and gases)?	Yes (if transparent or translucent)	Yes
Can they travel through a vacuum?	Yes	No
How are they detected?	Eyes, cameras	Ears, microphones
Can they be reflected?	Yes	Yes
Can they be refracted?	Yes	Yes

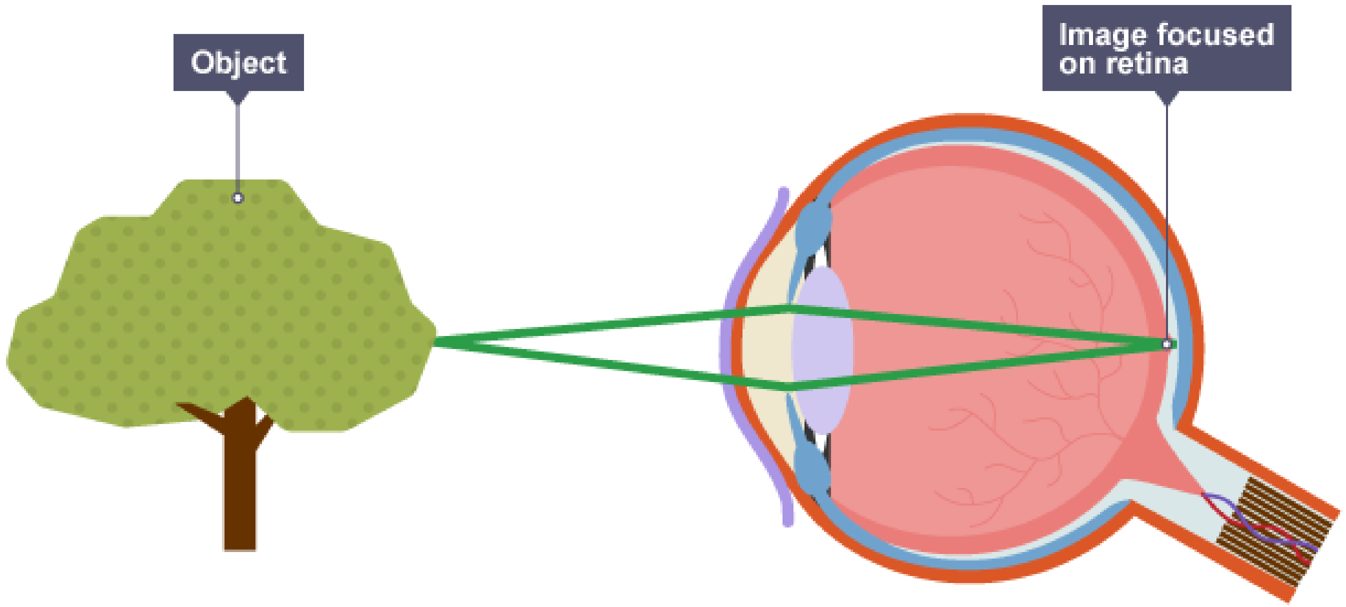
Detecting light

Cameras and our eyes detect light. In each case, they have:

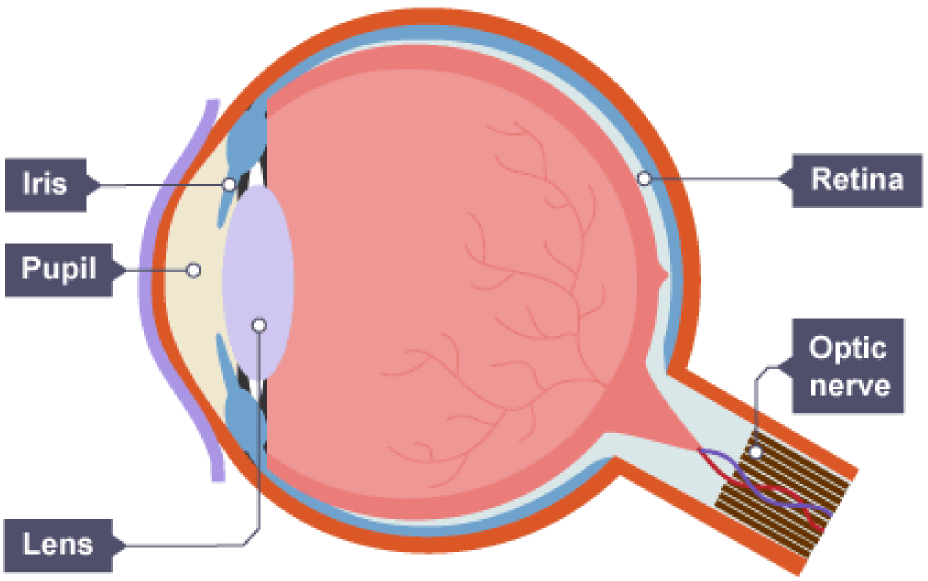
- a material that is sensitive to light
- a change that happens when this material absorbs light

The eye

Like the camera, the eye focuses light from an object onto a photo-sensitive material. However, in the eye, this material is the **retina**. The retina contains cells that are sensitive to light. They produce electrical impulses when they absorb light. These impulses are passed along the optic nerve to the brain, which interprets them as vision.



Light is focused onto the retina of the eye

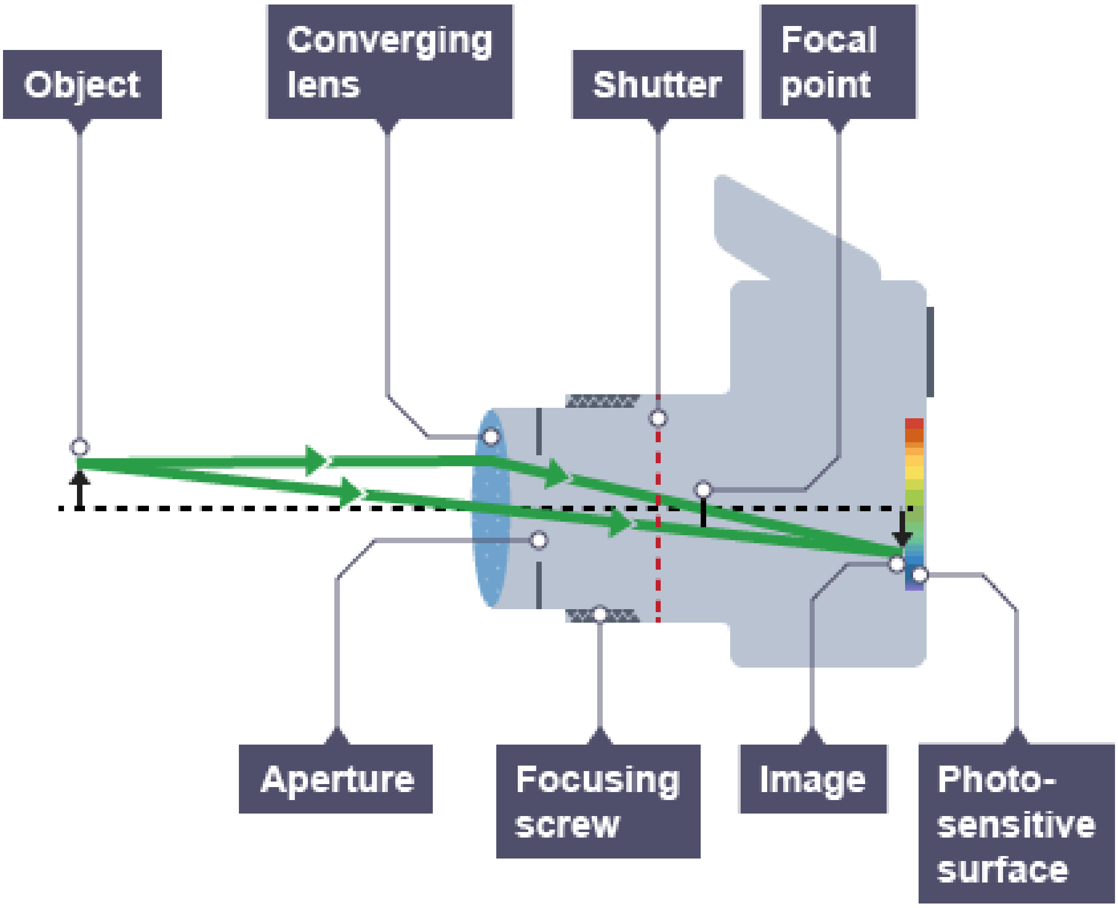


Component parts of the eye

The camera

Cameras are devices that focus light from an object onto a **photo-sensitive material** using a lens. In an old-fashioned camera, the photo-sensitive material was camera film. When the film absorbed light, a chemical change produced an image in the film, called the 'negative'. This was used to produce a photograph on photo-sensitive paper.

In a modern camera or the camera in a mobile phone, the photo-sensitive material produces electrical impulses, which are used to produce an image file. This can be viewed on the screen, or its information sent to a printer.



A cross-section of a camera

Reflection

A **ray diagram** shows how light travels, including what happens when it reaches a surface. In a ray diagram, you draw each ray as:

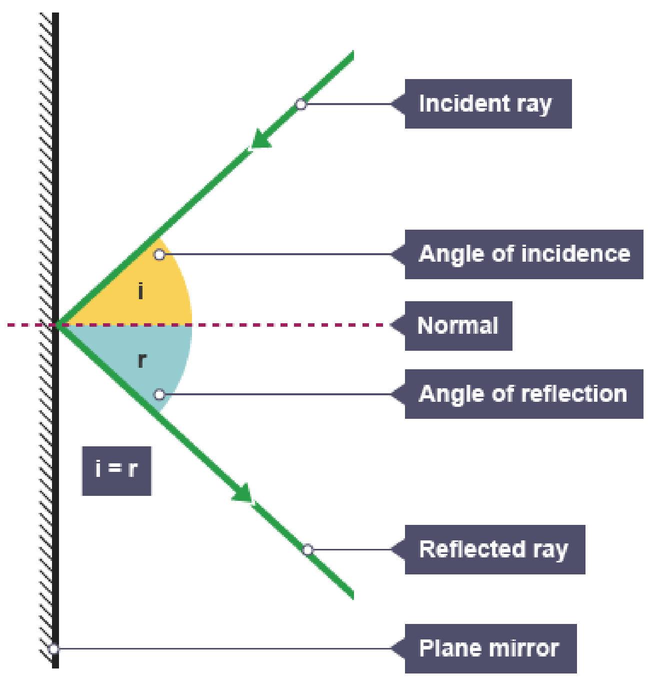
- a straight line
- with an arrowhead pointing in the direction that the light travels

Remember to use a ruler and a sharp pencil.

The law of reflection

When light reaches a mirror, it reflects off the surface of the mirror:

- the **incident ray** is the light going towards the mirror
- the **reflected ray** is the light coming away from the mirror



A ray diagram for reflection at a mirror

In the ray diagram:

- the hatched vertical line on the right represents the mirror
- the dashed line is called the **normal**, drawn at 90° to the surface of the mirror
- the **angle of incidence**, i, is the angle between the normal and incident ray
- the **angle of reflection**, r, is the angle between the normal and reflected ray

The **law of reflection** states that the angle of incidence equals the angle of reflection, i = r. It works for any angle. For example:

- the angle of reflection is 30° if the angle of incidence is 30°
- the angle of reflection is 90° if the angle of incidence is 90°

In the second example, if a light ray travelling along the normal hits a mirror, it is reflected straight back the way it came. The reflection of light from a flat surface such as a mirror is called **specular reflection** – light meeting the surface in one direction is all reflected in one direction.

Scattering

If light meets a rough surface, each ray obeys the law of reflection. However, the different parts of the rough surface point in different directions, so the light is not all reflected in one direction. Instead, the light is reflected in all directions. This is called **diffuse scattering**. It explains why you can see a clear image of yourself in a shiny flat mirror, but not in a dull rough wall.

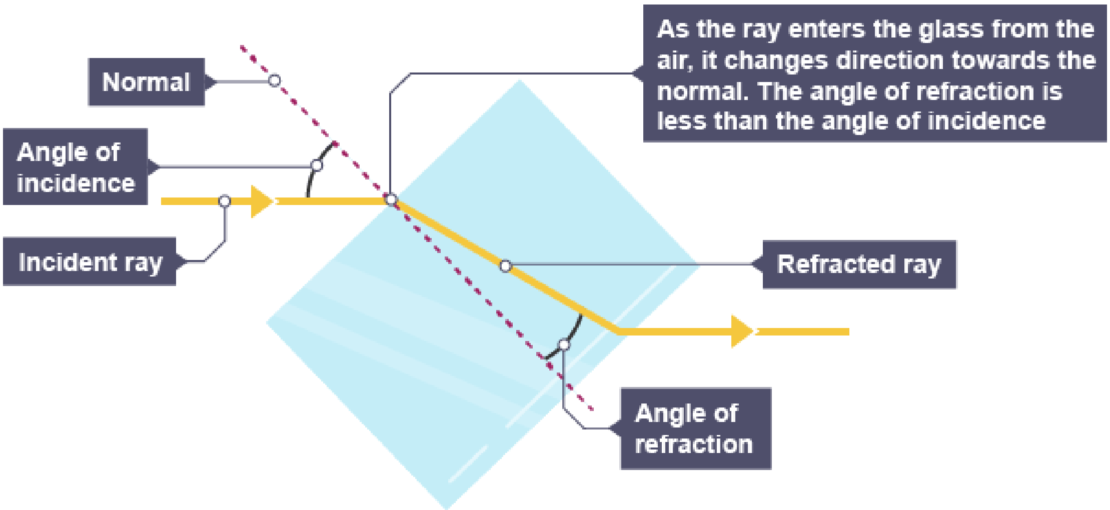
Refraction

Light waves change speed when they pass across the boundary between two substances with a different **density**, such as air and glass. This causes them to change direction, an effect called **refraction**.

At the boundary between two transparent substances:

- the light slows down going into a denser substance, and the ray bends towards the normal
- the light speeds up going into a less dense substance, and the ray bends away from the normal

The diagram shows how this works for light passing into, and then out of, a glass block. The same would happen for a Perspex block:



Refraction in a glass block. When light passes from air through a block with parallel sides, it emerges parallel to the path of the light ray that entered it.

Refraction explains why an object appears to bend when it goes through water.

Refraction at the boundary between air and water

Activities:

Watch this video: https://www.youtube.com/watch?v=hjKme3ci8W0

Task	Description
1	Explain: • How do we see things? • The formation of shadows • Draw a diagram of a pinhole camera and explain how pinhole cameras suggest that light travels in straight lines.
2	Define 'reflection' and explain in your own words how the periscope could help you see over a wall.
3	Refraction and dispersion effects: Write all the factors that affects the way light travels through different Materials.
4	Plants need light to make food. What would happen if you tried to grow plants under green light? Explain your answer using the words absorb, transmit and reflect.
5	Mary's parents are thinking about confiscating her drum kit. What could Mary do to stop the noise leaving her room? Use words reflect, transmit, absorb and energy in your answers.
6	Make a glossary of the keywords from this topic. A glossary is a detailed list of keywords and their meanings or descriptions.