Physics Knowledge Organiser
Light

KPI 6.1: Describe how light interacts with different materials

General Properties of Light

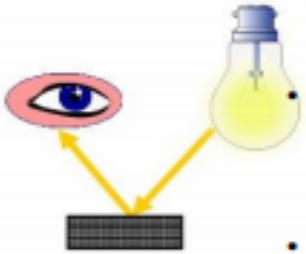
- Light travels as a wave
- Light can travel through gases, some liquids (e.g. water) and some solids (e.g. glass).
- Light travels fastest in a vacuum, slower in gases and liquids and slowest in solids, as solids are more dense.
- Light can interact with materials in three different ways:

1) Light is transmitted – it passes straight through
2) Light is absorbed – it does not pass through
3) Light is reflected – light bounces off the surface of the material

Transmission of Light Through Materials

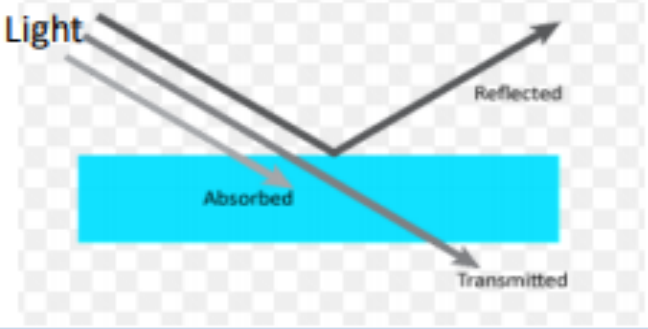
- Something that gives out light is **luminous** e.g. a lamp or the sun

- Most objects you see are **non–luminous**. You see them because they reflect light into your eyes.



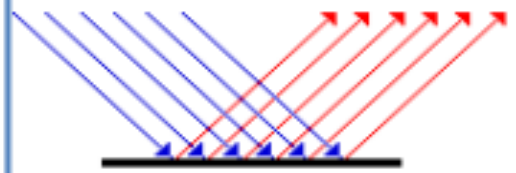
- Some materials completely transmit light, so light passes through and into your eye. These materials are transparent e.g. glass.
- Some materials only transmit some of the light, so you can't see clearly. These materials are **translucent** e.g. frosted glass
- Some materials do not transmit any light, so you can't see through them. These materials are **opaque** e.g. wood

Key Terms	Definitions
Luminous	Something that emits light
Transparent	Materials light completely travels through
Translucent	Materials light can partially travel through
Opaque	Materials light cannot travel through
Emit	Gives out light
Vacuum	An area that contains no particles

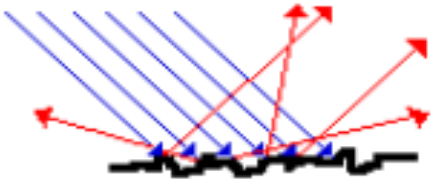


Diffuse Scattering & Specular Reflection

- Reflection from a smooth surface is called **specular reflection.** This happens because the light rays reflect at perfect angles.
- Reflection from a rough surface is called **diffuse scattering. This** happens because the light rays reflect at different angles.



Specular Reflection (smooth surfaces)



Diffuse Reflection (rough surfaces)

- To form an image, the rays from each part of the object have to reflect off a surface at the same angle. This only happens with perfect reflectors e.g. mirrors. That is why you can see your reflection.

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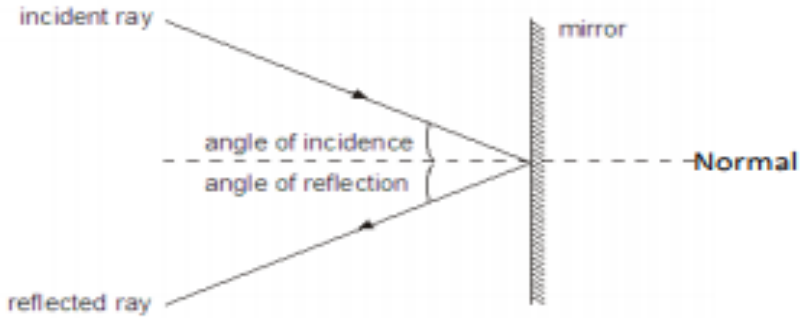
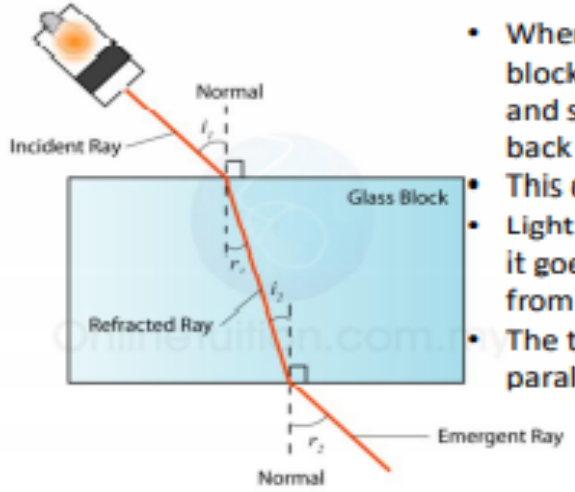
KPI 6.2: Use ray diagrams to show how images are formed – such as mirrors, pinhole cameras and the human eye

Reflection

- Light needs to reflect off an object and into your eye, for you to see it.
- When light is reflected from a mirror, the angle of incidence is equal to the angle of reflection. This is the **law of reflection**.



Refraction

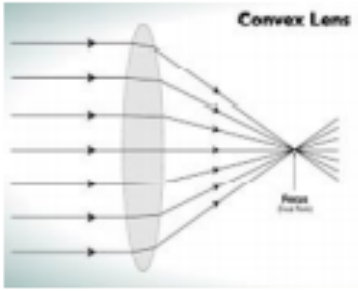


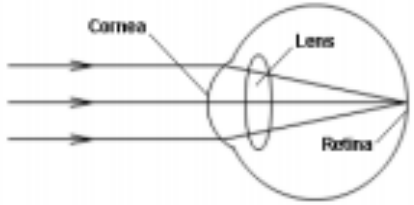
- When light travels through a glass block, it slows down when it goes in and speeds up again when it comes back out.
- This causes the light to refract (bend).
- Light bends towards the normal when it goes into glass and bends away from the normal when it comes out
- The two rays outside the block are parallel

Key Terms	Definitions
Incident ray	The ray of light that hits the mirror or glass block from the ray box
Reflected ray	The ray of light that reflects off the mirror
Normal line	Imaginary line at 90 degrees to the mirror or glass block. Used to measure angles.
Angle of reflection	The angle between the normal and reflected ray
Angle of incidence	The angle between the normal and the incident ray
Refraction	When light changes direction as it enters or leaves a different medium (material)
Emergent ray	The ray of light that leaves the glass block
Focus / focal point	The point where light rays cross

Lenses

- There are two types of lenses, **convex** and **concave**
- A convex lens In a convex lens, light is refracted as it goes into the lens and as it comes out, causing the light rays to converge (meet up).
- The point where the light rays converge is called the **focal point.**





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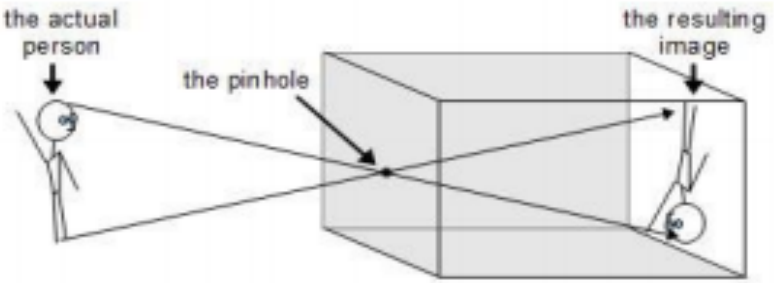
KPI 6.2: Use ray diagrams to show how images are formed – such as mirrors, pinhole cameras and the human eye

The Human Eye

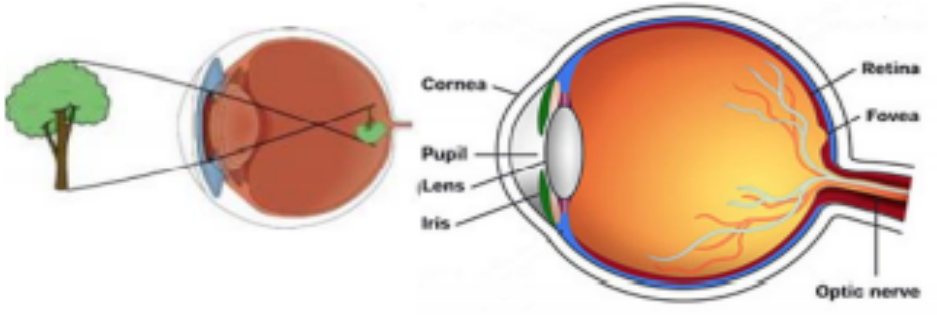
- Your eye contains a **convex lens**
- When you look at an object, light travels from the object into your eye.
- The **pupil** is a hole that lets light in and the **iris** is a muscle that controls the size of the pupil
- The light is refracted by the **cornea** as it enters the eye and the **lens**, causing light rays to refract and converge as an image on the retina.
- The image is **inverted** (upside down), but your brain corrects this so you see the image the right way up

A Pinhole Camera



- A **pinhole camera** is a simple **camera** without a lens but with a tiny aperture, a **pinhole**.
- Light from a scene passes through the aperture and projects an inverted image on the opposite side of the box.
- The image is projected onto photosensitive paper on the back of the box.
- The aperture needs to be really small, otherwise too much light would enter and the image would be blurry.

Key Terms	Definitions continued..
Photoreceptor Cells	Cells which are sensitive to light found on the retina in the eye i.e. rods and cones
Photo-sensitive	Sensitive to light



KPI 6.3: Describe the effects of absorption of light in terms of energy

Photosensitive Materials in the Eye and Cameras

- Both the retina in the eye and cameras contain **photo-sensitive material.**
- EYE: uses **photoreceptors** on the retina. Light energy hits these photoreceptors and chemical reactions take place to produce an electrical impulse. This travels up the optic nerve to the brain, so you can see. Energy is transferred from one store to another like so:
  Light → Chemical potential → Electrical
- OLDER CAMERAS: use photosensitive paper. When light hits the film a chemical reaction takes place that changes the film so you can see an image. Energy is transferred like so: *Light → Chemical potential*
- DIGITAL CAMERAS: use a grid of photosensitive pixels.

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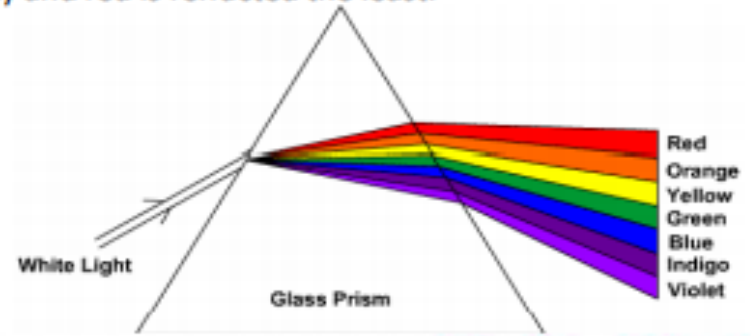
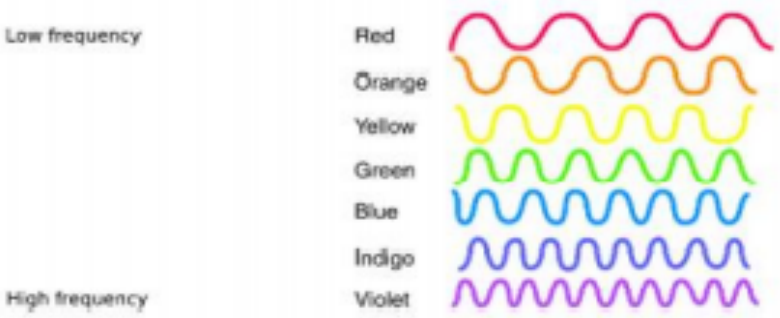
Light

KPI 6.3: Describe the effects of absorption of light in terms of energy

Dispersion of Light

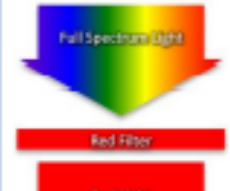
- White light is made up of seven different colours.
- You can use a **prism** to split white light into a **spectrum**. This is called **dispersion**
- The spectrum of white light is continuous as there are no gaps between the colours.
- Dispersion happens because different colours of light are **refracted** by different amounts.
- Light with a higher frequency is refracted more than light with a lower frequency. So violet is refracted the most as it has the highest frequency and red is refracted the least.

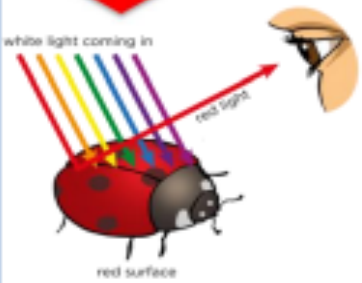




Key Terms	Definitions
Spectrum	The continuous range of colours in white light
Filter	Removes colours from white light
Prism	Pyramid shapes glass object used to disperse white light
Dispersion	The separation of white light into colours according to frequency

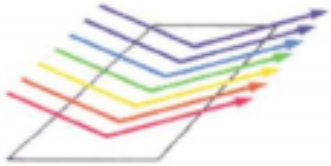
How We See Different Colours





- A **filter** only lets certain colours of light through, which changes the colour of the light on the other side e.g. a red filter transmits red light and absorbs all the others, so you see red
- Any coloured object reflects the colour that it is and absorbs the rest e.g. a blue pen box reflects blue and absorbs all other colours, so you see blue
- Black objects absorb all colours
- White objects absorb no colours and reflect all the light

- **Black – all colors absorbed, nothing reflected**



- **White – all colors reflected, nothing absorbed**

Key points to learn

Waves	Are oscillations or vibrations that have amplitude, wavelength and frequency. The top of a wave is a crest and the bottom is a trough.
Amplitude	The distance from the middle to the top or bottom of a wave
Wavelength	The distance from one point on a wave to the same point on the next wave
Frequency	The number of waves that go past a particular point per second, measured in Hertz (Hz)
Transverse wave	In a transverse wave the oscillation is at 90° to the wave direction
Longitudinal wave	In a longitudinal wave the oscillation is parallel to the wave direction
Reflection	Wave can reflect from barriers. The wave coming into the barrier is the incident wave. The wave bouncing of the barrier is the reflected wave.
Superpose	Waves when put together superpose meaning they add up or cancel out
Sound wave	Is produced by vibrating objects and is longitudinal. Sound needs a medium like a solid, liquid or gas to travel through.

Key points to learn

Speed of sound	Sound travels at 340 m/s. It travels fastest in solids and slowest in gases and cannot travel through a vacuum.
Loudness	The loudness of a sound depends upon its amplitude and is measured in decibels (dB)
Pitch	The pitch of a sound depends its frequency
Human's audible range	Is from 20-20000 Hz
Ear	Made up of three parts. The outer ear consists of the pinna, auditory canal and eardrum. The middle ear contains your ossicles. The inner ear contains your cochlea and semi-circular canals.
Hearing sound	Vibrations travel from your eardrum to the hairs in your cochlea. This produces a signal that is sent to the brain.
Echo	A reflection of sound that can use to work out distance. Soft materials absorb sound and don't produce echoes.
Ultrasound	Sound with a frequency of more than 20000 Hz. Used by humans to produce images of inside the body and to find the depth of water.

Sound Knowledge Organiser

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  - 1.2 Sound
  - 1.3 Light
  - 1.4 Space
  - 2.1 Electricity and magnetism
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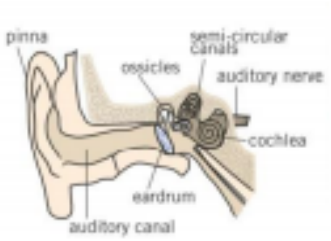
  - 2.3 Motion and pressure

Fantastic fact!

Grasshoppers make sounds that they cannot hear.

Additional Information



▲ Structure of the ear.

▲ Without these tiny hairs inside your cochlea you would not be able to hear.