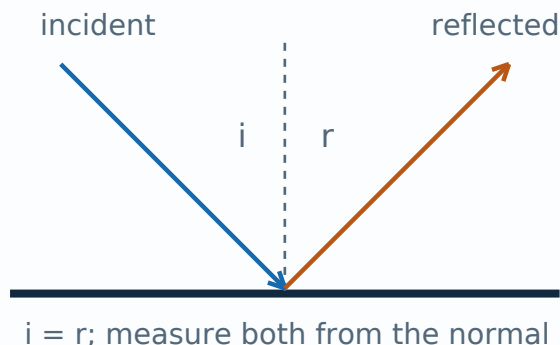


P6 Wave boundaries and practical rays

Separate Physics extras | AQA 8463 | CORE

Use alongside the shared topic notes. Foundation + Higher content.

Reflection at a boundary

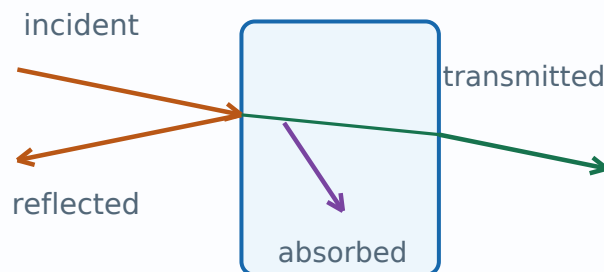


The angle of incidence equals the angle of reflection. Measure both angles from the **normal**, drawn at 90° to the surface.

Use a ruler for rays and a protractor for angles. Add arrowheads to show light's direction.

Different surfaces give different patterns: a smooth surface gives specular reflection; a rough surface scatters light in many directions.

Reflection, absorption, passage

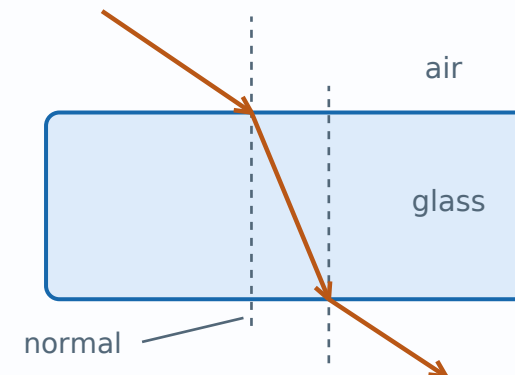


At a boundary, waves can be reflected, absorbed or transmitted. More than one process may happen.

Absorbed wave energy transfers to the material. Transmitted waves continue into or through the material.

A material can transmit some wavelengths and absorb others. The proportions depend on the material and the wave.

Required practical 9



Trace a block's outline. Shine a narrow ray into it, mark ray positions, remove the block and join the marks. Draw a normal at each boundary.

Measure angles from the normal. Repeat for different incidence angles or substances. Compare smooth and rough reflecting surfaces.

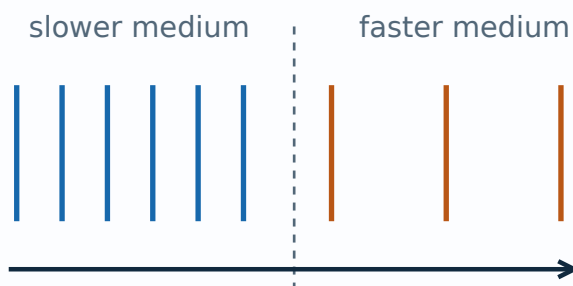
Use several well-spaced marks, fine pencil lines and a narrow ray. Avoid shining the ray box into eyes. The glass path shown bends towards the normal on entry.

P6 Sound speed, frequency and wavelength

Separate Physics extras | AQA 8463 | CORE

Use alongside the shared topic notes. Foundation + Higher content.

A boundary changes wave speed



Same frequency; wavelength is larger at right

The speed of sound depends on the medium. Sound can travel through solids, liquids and gases, but not a vacuum.

When a sound wave passes into a different medium, its frequency stays the same because it is set by the vibrating source.

If the speed changes while frequency stays fixed, the wavelength must change. The lines represent compressions, not paths followed by particles.

Use the shared wave equation

$$v = f \lambda$$

Wave speed v is in m/s, frequency f in Hz and wavelength λ in m.

Example: a 1000 Hz sound travels at 340 m/s in air. Its wavelength is $340 \div 1000 = \mathbf{0.340 \text{ m}}$.

In water at 1500 m/s, the same frequency gives a wavelength of $1500 \div 1000 = \mathbf{1.50 \text{ m}}$.

$$\lambda = \frac{v}{f}$$

Higher speed gives a longer wavelength for the same frequency. Use the wave speed for the medium named in the question.

Reason from observations

If a source produces 500 vibrations each second, every medium receives a 500 Hz disturbance. The boundary does not create extra oscillations.

A wavelength is the distance between neighbouring compressions, or between other corresponding points on successive waves.

Check: if speed doubles at unchanged frequency, wavelength doubles. If speed stays fixed and frequency doubles, wavelength halves.

Convert before calculating: 2 kHz = 2000 Hz; 40 cm = 0.40 m.

Do not use loudness as a measure of speed. Amplitude relates to the size of a disturbance, whereas speed, frequency and wavelength are linked by $v = f\lambda$.

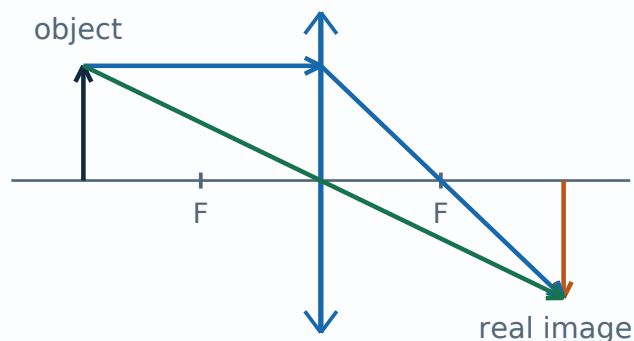
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P6 Lenses and image formation

Separate Physics extras | AQA 8463 | CORE

Use alongside the shared topic notes. Foundation + Higher content.

Convex: a real image

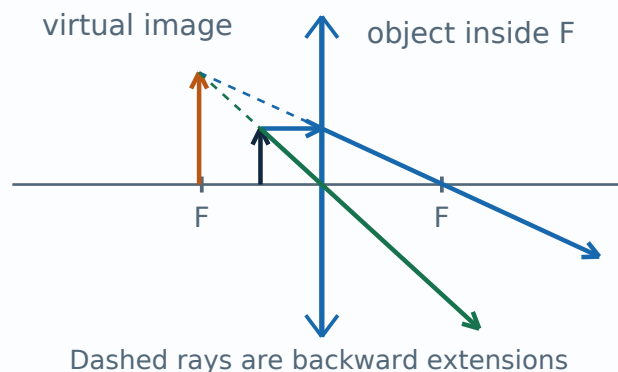


A convex lens converges parallel rays at its principal focus F. Focal length is the distance from lens to F.

For an object beyond F, a real image forms where the rays meet. It is inverted and can be projected onto a screen.

Draw a ray parallel to the axis, refracted through the far F, and a ray through the lens centre, continuing straight.

Convex: a virtual image

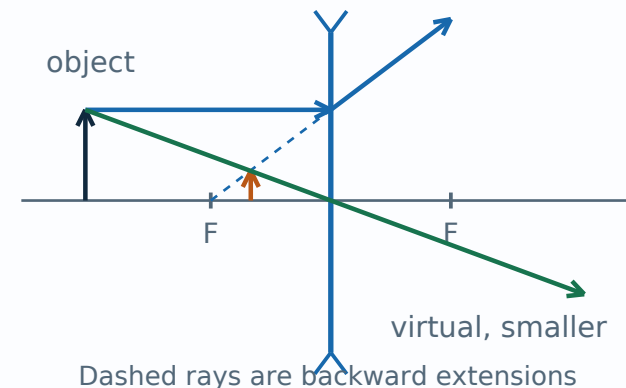


With the object between F and the convex lens, outgoing rays diverge. Their backward extensions meet on the object's side.

The image is **virtual, upright and magnified**. It cannot be projected onto a screen: actual rays do not meet at the image.

Draw backward extensions as dashed lines. A magnifying glass uses this arrangement.

Concave + magnification



A concave lens diverges rays and forms a virtual, upright, diminished image. A parallel ray emerges as if it came from the near F.

$$\text{magnification} = \frac{\text{image height}}{\text{object height}}$$

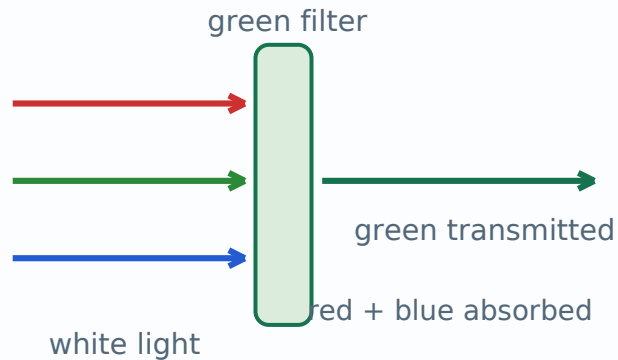
Use the same units for both heights. Magnification has no unit. A 30 mm image of a 10 mm object has magnification 3.

P6 Colour and thermal radiation

Separate Physics extras | AQA 8463 | CORE

Use alongside the shared topic notes. Foundation + Higher content.

Explain colour and filters



A filter transmits selected wavelengths and absorbs others. White light includes the full visible spectrum.

An opaque object's colour depends on the wavelengths it reflects. Under white light a red object reflects red more strongly and absorbs most other colours.

A red object illuminated only with green light looks dark if it absorbs that green light.

Surfaces and visible light

Each visible colour occupies a narrow band of wavelengths and frequencies. Red has a longer wavelength than violet.

White opaque surface: reflects visible wavelengths roughly equally. **Black opaque surface:** absorbs them strongly.

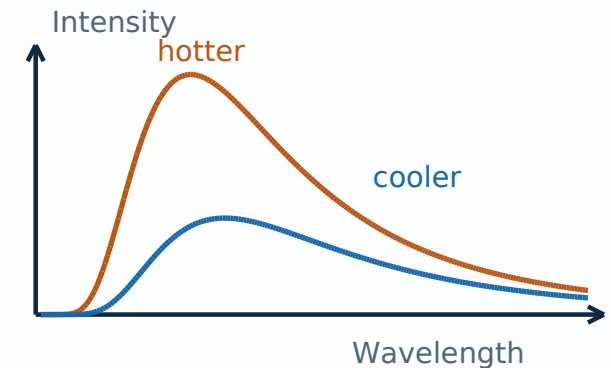
Transparent: transmits light with little scattering, so a clear image can be seen.

Translucent: transmits but scatters light.

Specular reflection sends parallel rays in one direction from a smooth surface. Diffuse reflection scatters them from a rough surface.

The law of reflection still applies at each point on a rough surface; the local normals differ.

Black bodies and temperature



All bodies emit and absorb infrared radiation. A hotter body emits more radiation per second.

A perfect black body absorbs all incident radiation: none is reflected or transmitted. It is also the best possible emitter.

Temperature changes both intensity and wavelength distribution. A hotter black body has a higher peak at a shorter wavelength. The curves are schematic.

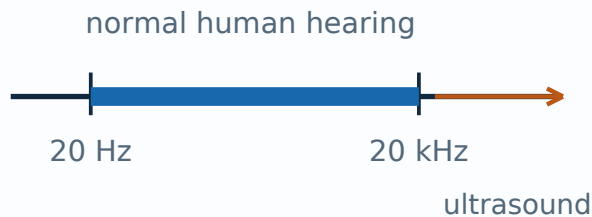
P6 Sound, echoes and hidden structures

Separate Physics extras | AQA 8463 | HIGHER ONLY

Use alongside the shared topic notes. Higher-tier material is kept on this separate page.

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Hearing and ultrasound



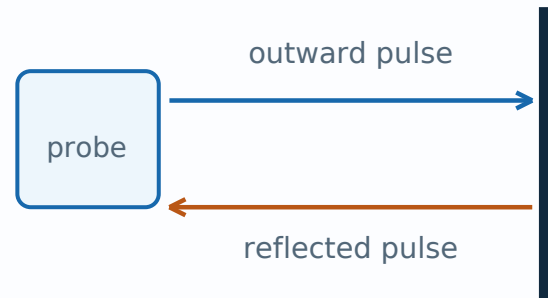
Vibrations are detected over a limited range

Sound causes solids to vibrate, including the eardrum and other parts of the ear. This produces the sensation of hearing.

Conversion between sound waves and solid vibrations works over a limited frequency range. Normal human hearing is about 20 Hz to 20 kHz.

Ultrasound has frequency above 20 kHz. Some animals can hear higher frequencies than humans.

Use echo times



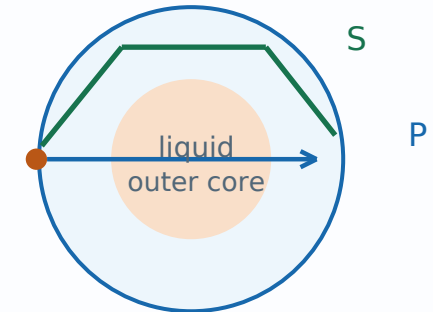
Measured time includes out + back

$$\text{distance} = \frac{\text{wave speed} \times \text{time}}{2}$$

A pulse partly reflects at a boundary between media. The echo time is for the outward and return journeys.

At 1500 m/s, an echo after 0.080 s locates a boundary 60 m away. Ultrasound images internal organs and detects flaws; echo sounding measures water depth.

Seismic evidence



S-waves cannot pass through liquid

Earthquakes produce seismic waves. **P-waves** are longitudinal and travel through solids and liquids at different speeds.

S-waves are transverse and do not travel through liquids. Their paths and missing arrival regions help reveal Earth's liquid outer core.

Differences in speed, absorption and reflection allow hidden structures to be inferred. New observations can change scientific models.

P6 Radiation balance and Earth

Separate Physics extras | AQA 8463 | HIGHER ONLY

Use alongside the shared topic notes. Higher-tier material is kept on this separate page.

Compare rates, not totals

Earth's energy balance

Interpret a change

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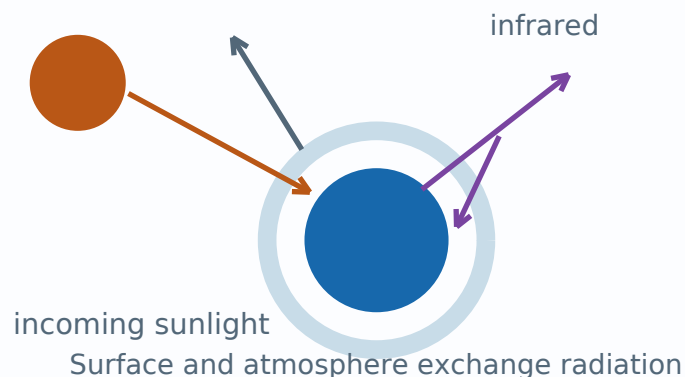
Equal rates $\rightarrow$ constant temperature

Rate means energy transferred per second

When radiation is the only energy-transfer mechanism, an object at constant temperature absorbs radiation at the same rate as it emits it.

In this model, if absorption is faster than emission, temperature rises. If emission is faster, temperature falls.

As temperature rises, emission increases. A new steady temperature can be reached when the rates balance again.



Earth's temperature depends on incoming radiation, the fraction reflected into space, and radiation emitted by the surface and atmosphere.

Some incoming solar radiation is reflected; some is absorbed. Earth emits infrared radiation.

The atmosphere absorbs and emits infrared. Changes in absorption, emission or reflection can alter the surface's equilibrium temperature.

Example: a surface absorbs 240 W/m^2 and emits 220 W/m^2 . With radiation as the only energy transfer, it gains energy at 20 W/m^2 and its temperature tends to rise.

$$\text{net rate} = \text{absorbed} - \text{emitted}$$

If reflective cloud cover or ice changes, the fraction of sunlight absorbed can change. Use the information supplied to predict the direction of the effect.

At the eventual steady temperature, the overall rates balance. This does not mean radiation stops passing between the surface, atmosphere and space.

Always define the system in a diagram: a surface, the atmosphere, or Earth as a whole.