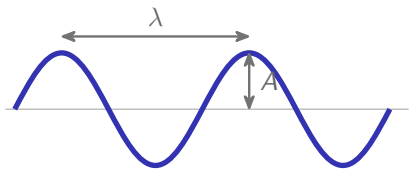
Waves

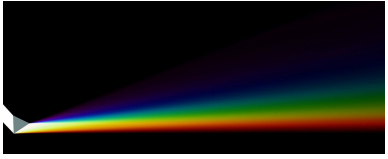
IGCSE Physics ▪ Topic 3

IGCSE Physics

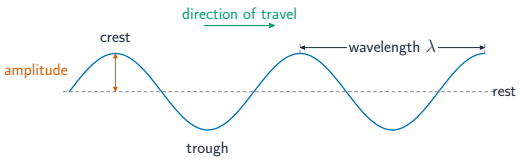


What we will cover

1. Wave properties
2. Reflection & refraction
3. Lenses & dispersion
4. Electromagnetic spectrum
5. Sound
6. Recap



Describing a wave



A **wave** 波 carries energy, not matter.

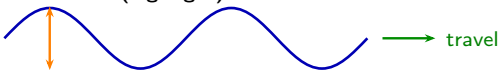
$$v = f\lambda.$$

Sound: $v = 340\,\mathrm{m/s}$, $f = 170\,\mathrm{Hz}$

$$\lambda = \frac{340}{170} = 2.0\,\mathrm{m}$$

Two types; three behaviours

transverse (e.g. light)



particles vibrate $\perp$ to travel

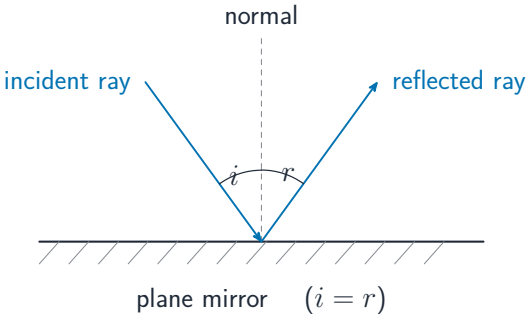
longitudinal (e.g. sound)

particles vibrate $\parallel$ to travel

transverse $\perp$, longitudinal $\parallel$

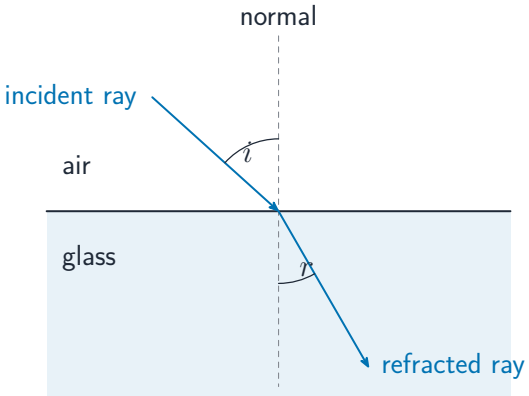
Convex lens

Reflection



Microphone sound

Refraction



bends towards the normal ($i > r$)

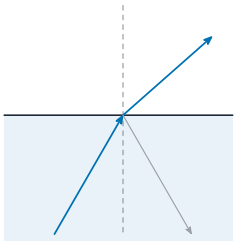
Light bends as it changes speed.
Refractive index 折射率:

$$n = \frac{\sin i}{\sin r}.$$

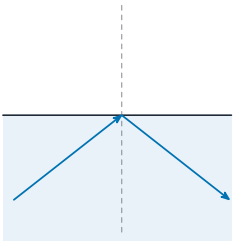
$i = 60°$, $r = 35°$

$$n = \frac{0.87}{0.57} = 1.5$$

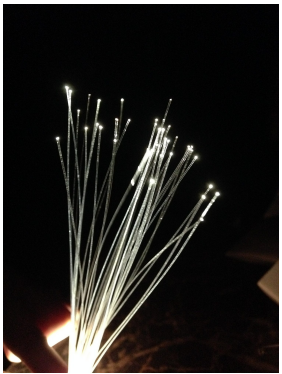
Total internal reflection



angle $<$ critical:
light refracts out

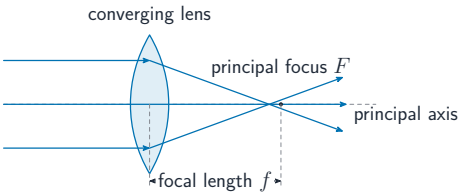


angle $>$ critical:
total internal reflection

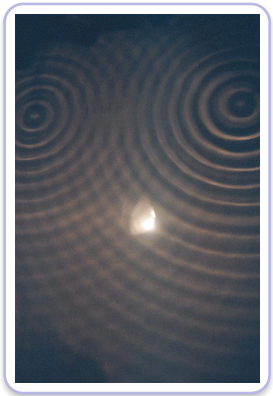


Optical fibre

Lenses and dispersion



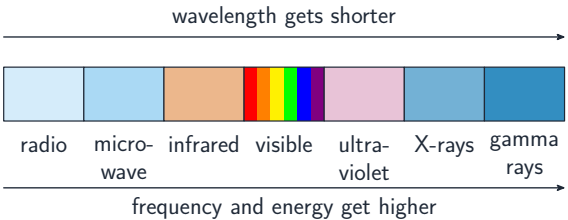
converging lens 凸透镜*: rays to the* ***focus*** 焦点



Ripple tank

Violet bends most, red least: red, orange, yellow, green, blue, indigo, violet.

The electromagnetic spectrum



All travel at $3.0 \times 10^8\,\mathrm{m/s}$ in a vacuum.

> Radio → gamma: frequency & energy rise, wavelength falls.

radio → **microwave** 微波 → **infrared** 红外线 → visible → **ultraviolet** 紫外线 → X-ray → gamma

Sound

Sound is a **longitudinal** 纵波 wave of **compressions** 压缩 and **rarefactions** 稀疏.

- needs a **medium** 介质 – not a vacuum
- we hear 20 to $20\,000\,\mathrm{Hz}$

Echo: $85\,\mathrm{m}$ **wall,** $0.50\,\mathrm{s}$

$$v = \frac{2 \times 85}{0.50} = 340\,\mathrm{m/s}$$

Topic 3 – key takeaways

1 Wave equation

$v = f\lambda$; transverse vs longitudinal

2 Light

reflection $i = r$; refraction $n = \sin i / \sin r$

3 TIR

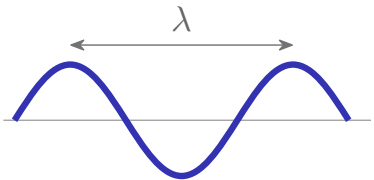
above the critical angle; optical fibres

4 Spectrum

radio $\rightarrow$ gamma: energy rises

Check yourself

1. A wave: $f = 50\,\mathrm{Hz}$, $\lambda = 4\,\mathrm{m}$ – find v.
2. Is sound transverse or longitudinal?
3. What happens above the critical angle?
4. Which travels faster in air: light or sound?



Answers **1.** $v = f\lambda = 200\,\mathrm{m/s}$ **2.** longitudinal **3.** total internal reflection **4.** light