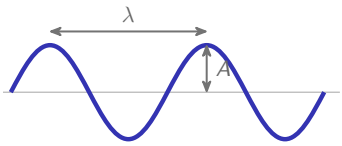
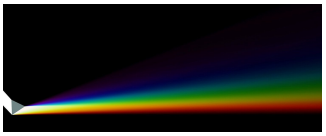
Waves

IGCSE Physics ▪ Topic 3

IGCSE Physics

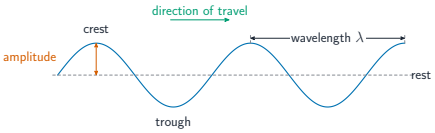


What we will cover



1 Wave properties

Describing a wave



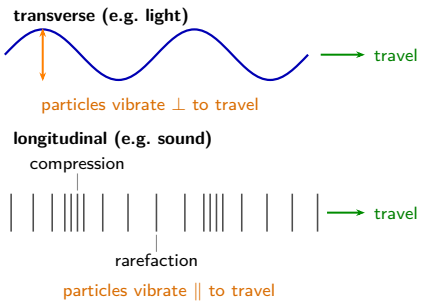
A **wave** 波 carries energy, not matter.

$$v = f\lambda.$$

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

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

Two types; three behaviours



transverse ⊥, *longitudinal* ∥

- **transverse** 横波 – particles ⊥ travel (light, water)
- **longitudinal** 纵波 – particles ∥ travel (sound)

All waves reflect, refract and diffract. Speed $v = f\lambda$.

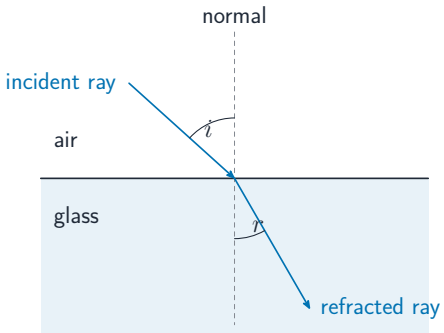
2 Light

Reflection

- angle of incidence = angle of reflection, from the **normal** 法线
- the incident ray, reflected ray and normal lie in one plane

> The **normal** 法线 is the line at $90°$ to the surface at the point of incidence.

Refraction



bends towards the normal ($i > r$)

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

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

$i = 60°$, $r = 35°$

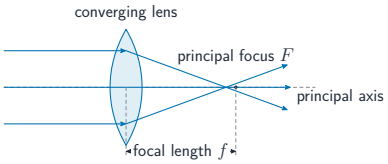
$$n = \frac{0.87}{0.57} = 1.5$$

Total internal reflection

Light going from a denser medium towards a less dense one: if the angle of incidence is greater than the **critical angle** 临界角, it reflects entirely. Optical fibres use this to carry signals.

$$\sin c = \frac{1}{n}$$

Lenses and dispersion



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

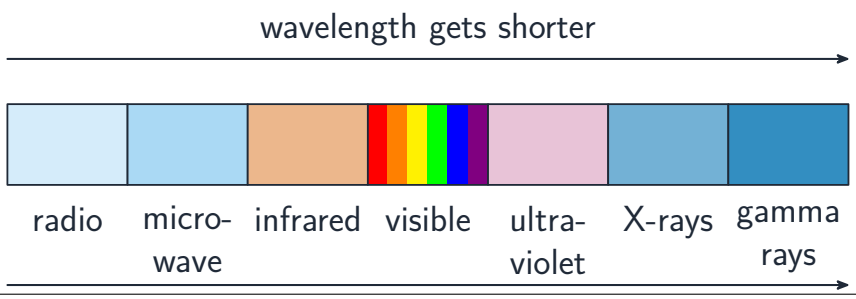
Violet bends most, red least: red, orange, yellow, green, blue, indigo, violet.

3 EM spectrum and sound

The electromagnetic spectrum

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

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



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 Hz

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

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

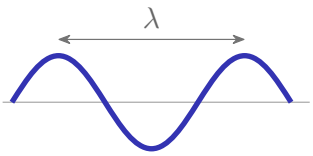
4 Recap

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