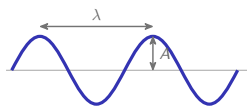


Waves

IGCSE Physics • Topic 3

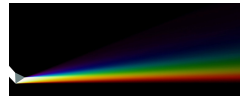
IGCSE Physics



Waves

What we will cover

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

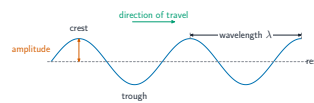


1 Wave properties

Waves

Wave properties

Describing a wave



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

$$v = f\lambda$$

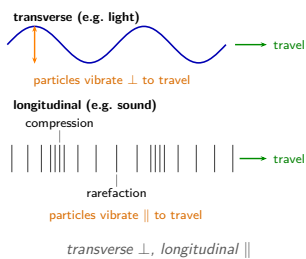
Sound: $v = 340 \text{ m/s}$, $f = 170 \text{ Hz}$

$$\lambda = \frac{340}{170} = 2.0 \text{ m}$$

Waves

Wave properties

Two types; three behaviours



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

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

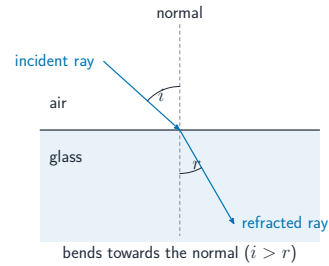
2 Light

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



Light bends as it changes speed.

Refractive index 折射率:

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

$$i = 60^\circ, r = 35^\circ$$

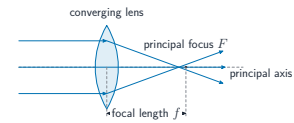
$$n = \frac{0.87}{0.57} = 1.5$$

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

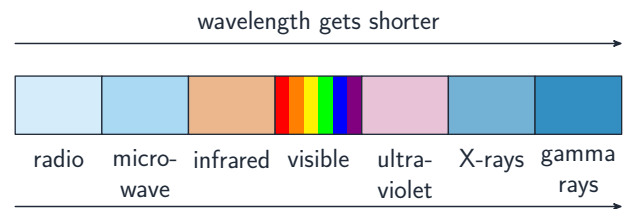
Violet bends most, red least: red, orange, yellow, green, blue, indigo, violet.

3 EM spectrum and sound

The electromagnetic spectrum

All travel at 3.0×10^8 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 m wall, 0.50 s

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

4

Recap

Topic 3 – key takeaways

1 Wave equation

$v = f\lambda$; transverse vs longitudinal

2 Light

reflection $i = r$, refraction $n = \frac{\sin i}{\sin r}$

3 TIR

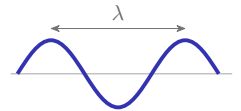
above the critical angle; optical fibres

4 Spectrum

radio → gamma: energy rises

Check yourself

- 1 A wave: $f = 50 \text{ Hz}$, $\lambda = 4 \text{ m}$ – 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. $v = f\lambda = 200 \text{ m/s}$ 2. longitudinal 3. total internal reflection 4. light