

P6 Waves

Physics Paper 2 | AQA Combined Science Trilogy | Key ideas to remember

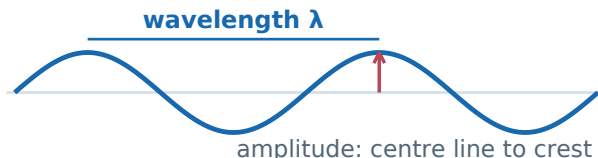
Energy transfer

Wave measurements

Electromagnetic waves

Practical skills

1 Wave motion



Waves transfer **energy**. Material oscillates locally. A floating marker rises and falls as ripples pass, staying near its original position.

Transverse: oscillations perpendicular to energy transfer. **Longitudinal:** parallel. Compressions are crowded; rarefactions spread out. Sound is longitudinal.

Amplitude: maximum displacement from equilibrium. **Wavelength:** distance between equivalent neighbouring points.

2 Equations and sound speed

$$T = \frac{1}{f}$$

$$v = f\lambda$$

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

Frequency f : waves per second (Hz). **Period T :** time per cycle (s). **Speed v :** m/s. **Wavelength λ :** m. A distance graph gives λ ; a time trace gives T .

$f = 5 \text{ Hz} \rightarrow T = 0.20 \text{ s}$. With $\lambda = 0.40 \text{ m}$, $v = 5 \times 0.40 = \mathbf{2.0 \text{ m/s}}$. Convert cm to m before calculating. At fixed speed, doubling f halves λ .

Sound: measure microphone separation and electronic delay. $v = \text{distance/time}$. $1.02 \text{ m} / 0.003 \text{ s} = \mathbf{340 \text{ m/s}}$. Repeat; use the first arrival, not an echo. For an echo method, include the outward **and return** distance.

3 Required practical 20

Water: ripple tank, vibrating dipper and lamp. Measure several gaps using a real or calibrated scale. Five crests contain **four wavelengths**.

Four gaps span 20 cm: $\lambda = 0.20/4 = \mathbf{0.050 \text{ m}}$. At 10 Hz, $v = \mathbf{0.50 \text{ m/s}}$. Verify frequency or count cycles over time. Keep depth steady; repeat.

Solid: signal generator drives a stretched string. Two stationary loops span one wavelength. Two loops in 0.60 m at 50 Hz: $v = \mathbf{30 \text{ m/s}}$. Keep string, length and tension fixed.

The stationary pattern does not travel; use it to measure λ . Secure apparatus; keep electricity away from water.

4 The electromagnetic spectrum

Radio $\rightarrow$ microwave $\rightarrow$ infrared $\rightarrow$ visible $\rightarrow$ ultraviolet $\rightarrow$ X-ray $\rightarrow$ gamma

Frequency increases $\rightarrow$
Wavelength increases $\leftarrow$

All are transverse, transferring energy from source to absorber. They cross a vacuum at $\mathbf{3 \times 10^8 \text{ m/s}}$. Eyes detect visible light: red to violet.

Uses: radio: broadcasting; microwaves: satellites/cooking; IR: heaters/cooking/cameras; visible: fibre communication; UV: efficient lamps/tanning; X-rays/gamma: imaging/treatment.

EM waves arise from atomic/nuclear changes. **Gamma originates in nuclei.**

5 Refraction and infrared practical

Refraction: draw boundary, perpendicular normal and ray arrows. Air $\rightarrow$ glass: towards normal; glass $\rightarrow$ air: away. Along the normal: no change in direction.

RP21: compare IR absorption or emission. Matte black is a good absorber/emitter; shiny metal is poor, under matched conditions.

Absorption: heat identical black/shiny objects; compare temperature rises. Match starting temperature, mass, area, heating time and lamp distance.

Emission: hot Leslie cube and IR detector. Match face temperature, detector distance, angle and sampled area. Repeat. Take care with hot water and lamps.

6 Radiation risk + Higher Tier

Core: UV ages skin and increases cancer risk. X-rays/gamma ionise and can damage genes. Risk depends on type and dose. $1000 \text{ mSv} = 1 \text{ Sv}$.

HIGHER TIER ONLY

Refraction: speed and wavelength change; frequency stays constant. Fronts are perpendicular to rays. Wave interactions depend on material and wavelength.

Radio: electrical oscillations emit waves; absorption can induce AC at the same frequency.

Suitability: microwaves cross the atmosphere; IR heats; UV causes fluorescence; X-ray absorption makes images; gamma kills cells.