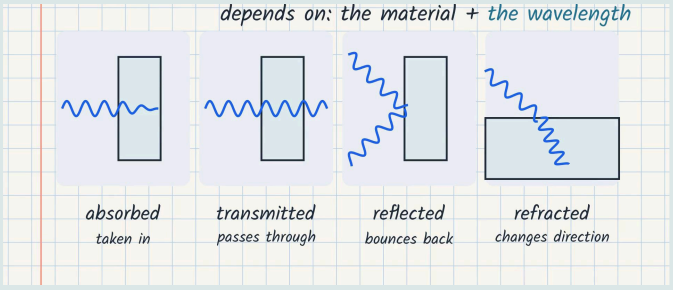
Refraction

Why waves change direction

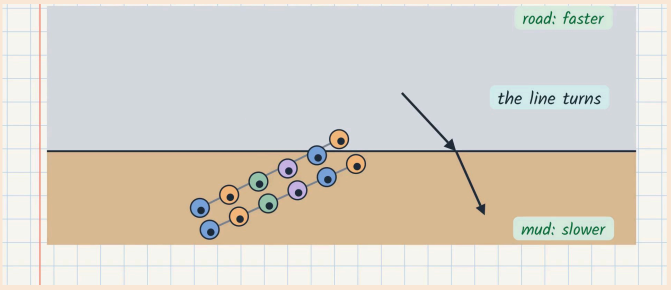
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Summary sheet

1 At a boundary



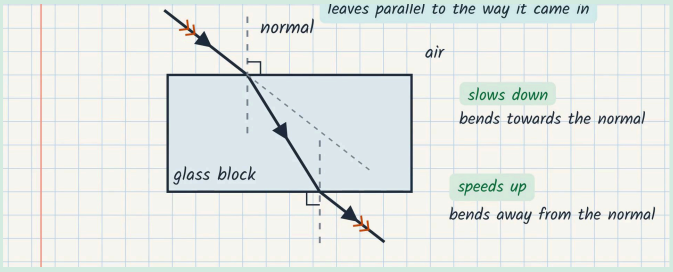
- A wave meeting a new material can be **absorbed**, **transmitted**, **reflected** or **refracted**.
- Which happens depends on the material and the **wavelength**: glass lets visible light through; a brick wall stops light but **radio waves** pass through.

2 Why it happens



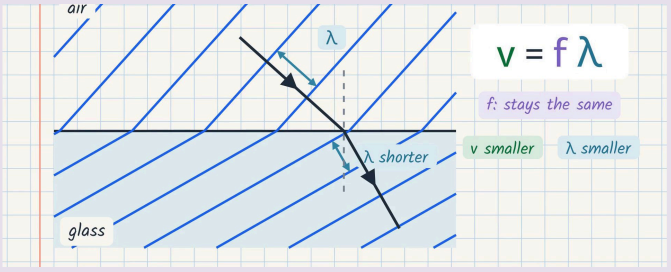
- Light travels **more slowly in glass** than in air. **Refraction** is the change in direction caused by this **change in speed**.
- Marching band onto mud at an angle: the side that reaches the mud first slows first, so the line turns. Head-on (at 90°): it slows but **does not turn**.

3 Ray diagrams



- Draw the **normal**: a dashed line at 90° to the surface where the ray hits.
- Into glass: slows, bends **towards** the normal. Out into air: speeds up, bends **away**. A rectangular block: the ray leaves **parallel** to the way it came in.

4 Wave fronts



- A **wave front** joins the same point on a wave (e.g. each crest); fronts are at 90° to the ray.
- Slower in glass, so the fronts get **closer together** (shorter λ) and turn. **Frequency stays the same**; only v and λ change (v = f λ).

$$v = f \lambda$$

f stays the same; v and λ both get smaller in glass

Exam tip

Explaining refraction? Always mention speed: "The light slows down in the glass, so it changes direction."

Check yourself

1. Light passes from glass into air. Towards or away from the normal?
2. Why doesn't a ray change direction when it hits glass at 90°?

Answers: 1. Away from the normal: it speeds up 2. The whole wave front slows at the same moment, so no side gets ahead