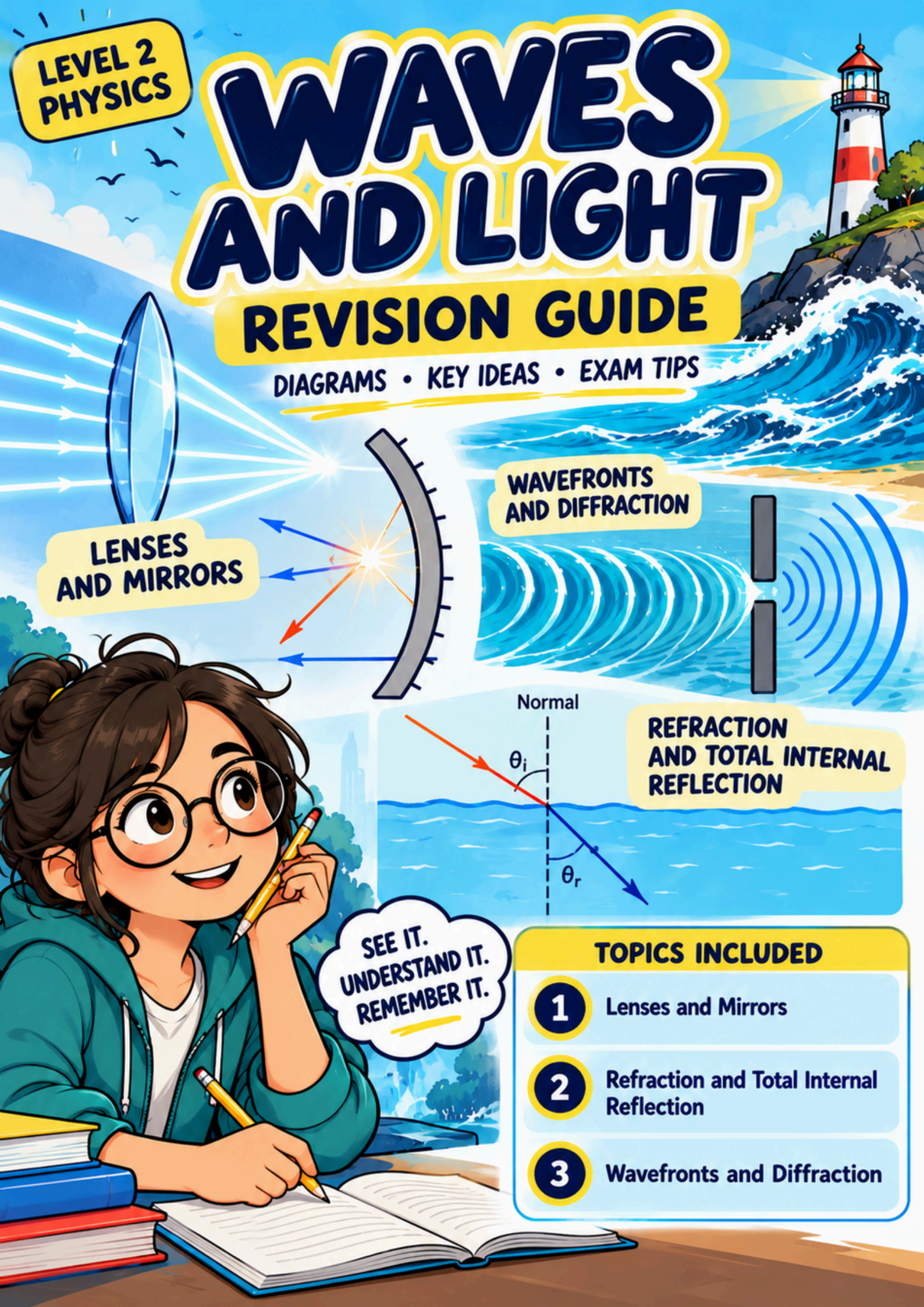
LEVEL 2 PHYSICS

WAVES AND LIGHT

REVISION GUIDE

DIAGRAMS • KEY IDEAS • EXAM TIPS



TOPICS INCLUDED

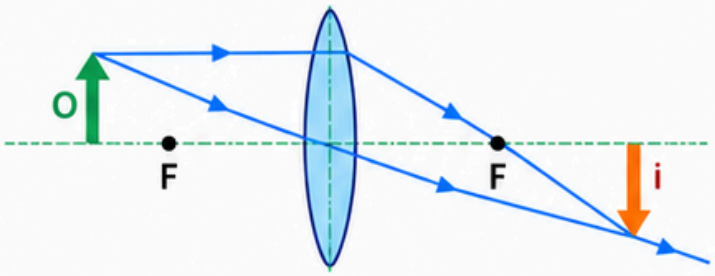
1. Lenses and Mirrors
2. Refraction and Total Internal Reflection
3. Wavefronts and Diffraction

1. LENSES AND MIRRORS

1 REAL vs VIRTUAL

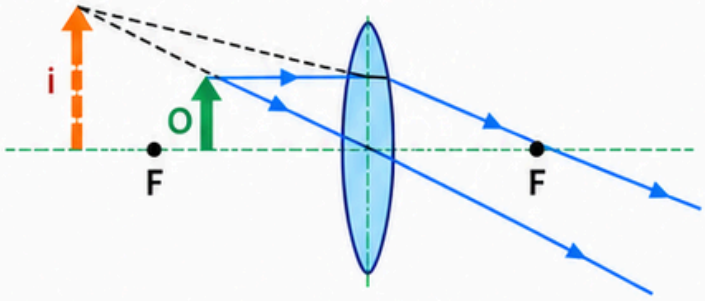
REAL IMAGE

- Rays actually meet.
- Can be formed on a screen.



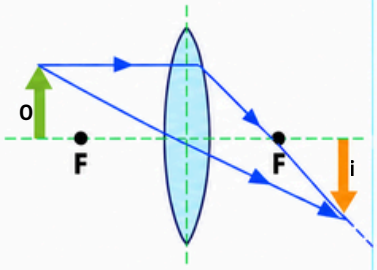
VIRTUAL IMAGE

- Rays only appear to meet.
- Cannot be formed on a screen.

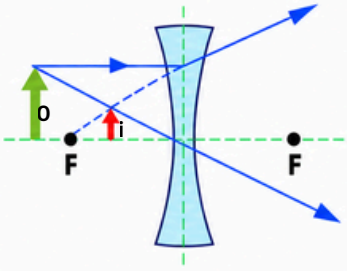


2 RAY RULES

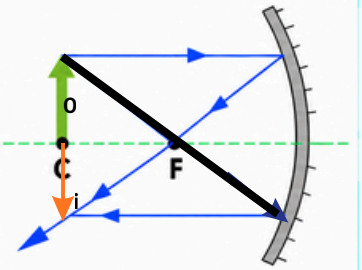
Convex lens (converging lens)



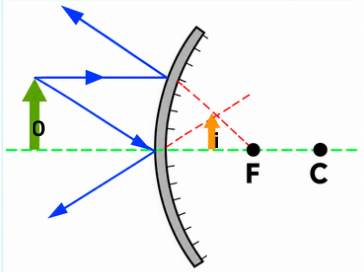
Concave lens (diverging lens)



Concave mirror (converging mirror)



Convex mirror (diverging mirror)



3 DESCRIBE EVERY IMAGE – SAT

S Size

- magnified
- same
- diminished

A Attitude

- upright
- inverted

T Type

- real
- virtual

4 IMAGE FORMATION – LENSES & MIRRORS

Convex lens (converging lens)



- Usually **real** and **inverted**.
- Can be **virtual, upright and magnified** when the object is inside F.
- **Object at F →** image at infinity (no image at a finite distance).

Concave lens (diverging lens)



- Always **virtual, upright and diminished.**

Concave mirror (converging mirror)



- Usually **real** and **inverted**.
- Can be **virtual, upright and magnified** when the object is inside F.
- **Object at F →** image at infinity (no image at a finite distance).

Convex mirror (diverging mirror)



- Always **virtual, upright and diminished.**

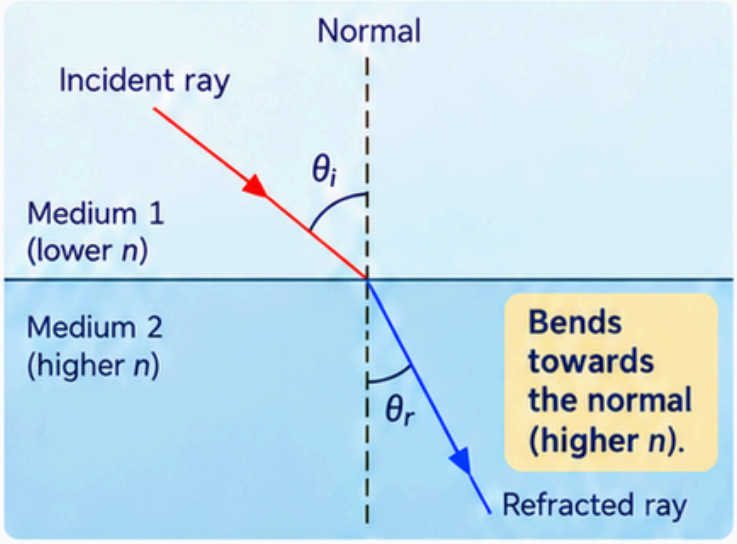
KEY IDEAS

- **Diverging** lens or mirror → Always **virtual, upright and smaller.**
- **Converging** lens or mirror → Image depends on the object's position.
- If the **object is at the focus (F)** of a converging lens or mirror → rays are parallel, **image at infinity** (no image at a finite distance).

2. REFRACTION AND TOTAL INTERNAL REFLECTION

REFRACTION

Refraction is the change in direction of a wave because its speed changes when it enters a different medium.



WHAT CHANGES?

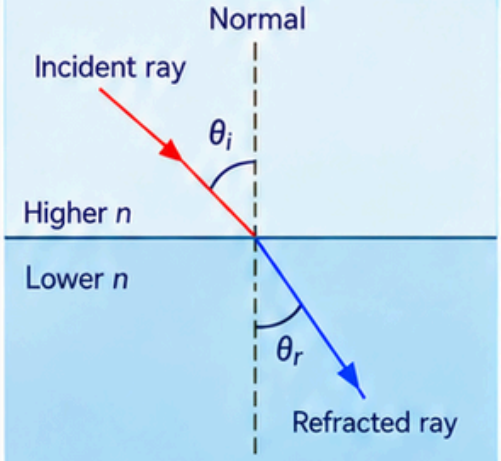
Higher refractive index (higher n)	• Speed decreases. • Wavelength decreases. • Bends **towards** the normal.
Lower refractive index (lower n)	• Speed increases. • Wavelength increases. • Bends **away** from the normal.
Frequency	• Frequency stays **constant.**

TOTAL INTERNAL REFLECTION — BOTH CONDITIONS

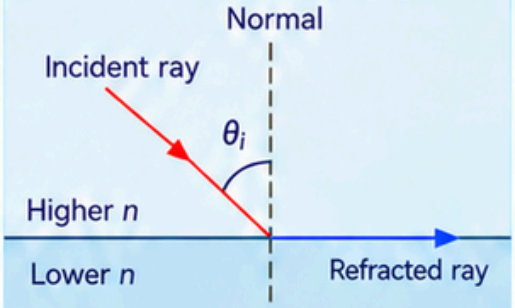
1. Light travels from **higher n to lower n.**

2. Angle of incidence is **greater than** the critical angle.

INCIDENCE ANGLE LESS THAN THE CRITICAL ANGLE (Refraction)

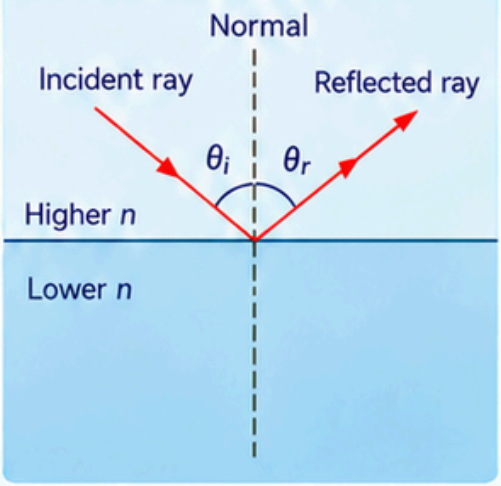


AT THE CRITICAL ANGLE (Refracted ray travels along the boundary)



At the critical angle, the refracted ray travels along the boundary: angle of refraction = 90°.

INCIDENCE ANGLE GREATER THAN THE CRITICAL ANGLE (Total Internal Reflection)



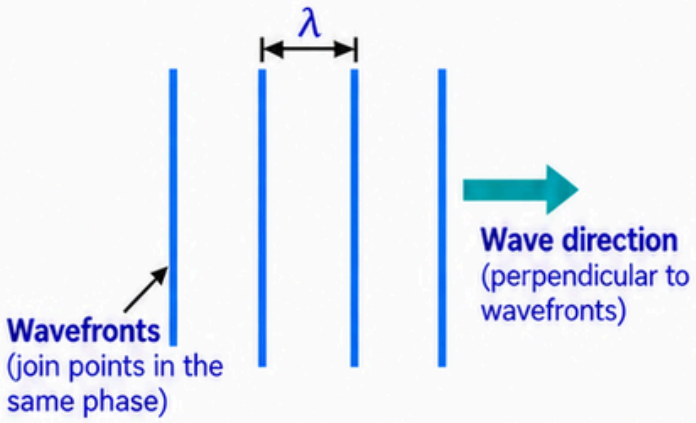
EXAM CHECK

Measure angles from the normal, not from the surface.

3. WAVEFRONTS AND DIFFRACTION

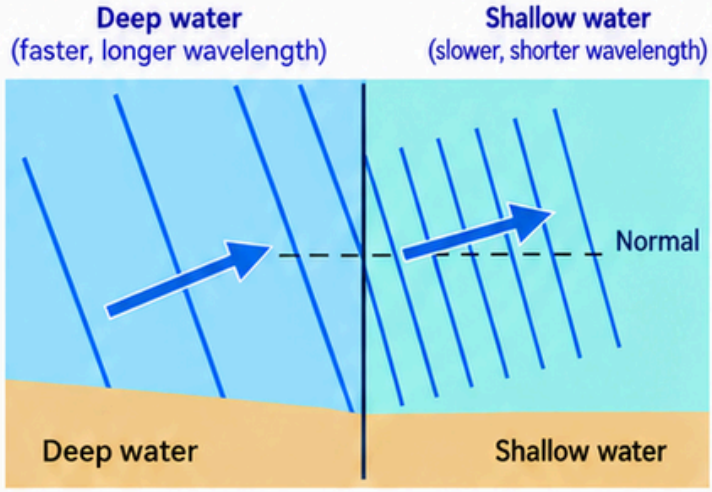
READING WAVEFRONTS

- Wavefronts join points in the same phase.
- Wave direction is perpendicular to the wavefronts.
- Distance between wavefronts = wavelength.



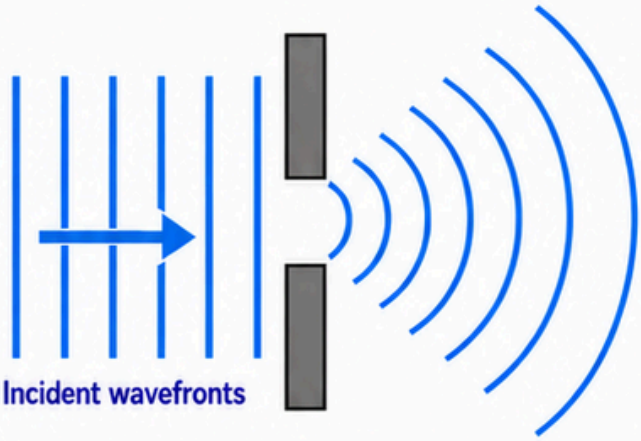
MOVING INTO SHALLOW WATER

- Speed decreases.
- Frequency stays constant.
- Wavelength decreases.
- The wave bends towards the normal.



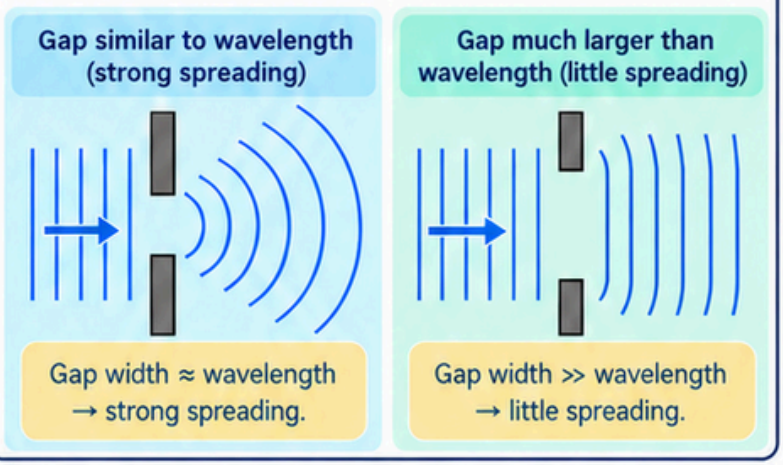
DIFFRACTION

- Diffraction is the spreading of waves around an obstacle or through a gap.



WHEN IS DIFFRACTION GREATER?

- Gap similar to wavelength → strong spreading.
- Gap much larger than wavelength → little spreading.
- Longer wavelength → more diffraction around the same obstacle.

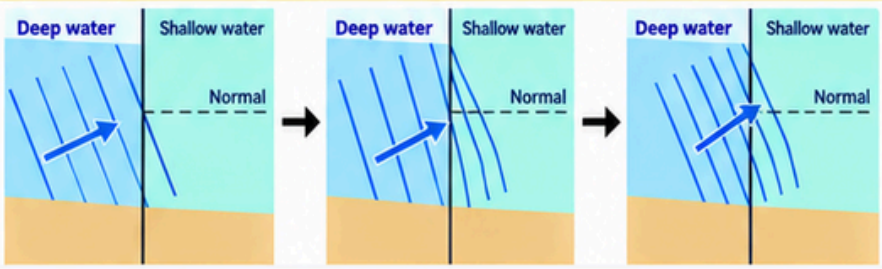


REMEMBER: Longer wavelength → greater diffraction for the same gap or obstacle.

WHY DOES THE WAVE BEND?

1. One side of the wavefront enters shallow water first.
2. That side slows down while the other side continues faster.
3. The wavefront pivots, so the wave changes direction towards the normal.

KEY LINK: Speed decreases → wavelength decreases; frequency stays constant.

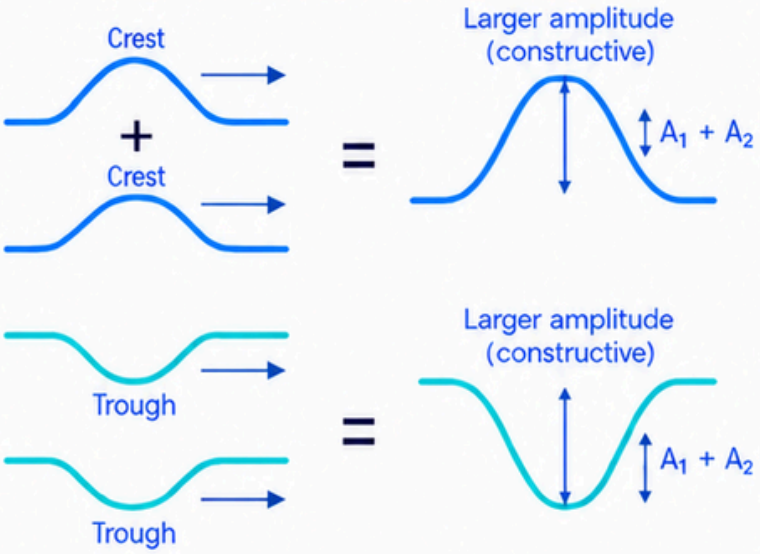


4. INTERFERENCE, SUPERPOSITION AND PULSES

1 CONSTRUCTIVE INTERFERENCE

Waves arrive in phase.
Crest meets crest or trough meets trough.
Amplitudes add → stronger signal.

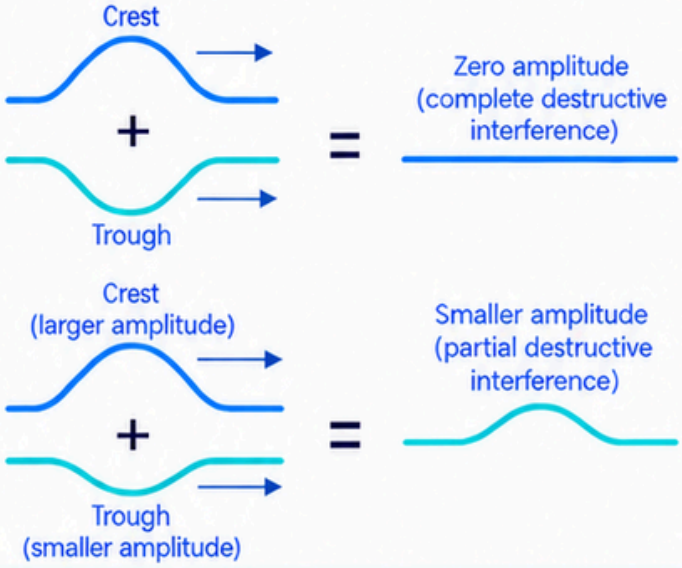
Path difference = $n\lambda$



2 DESTRUCTIVE INTERFERENCE

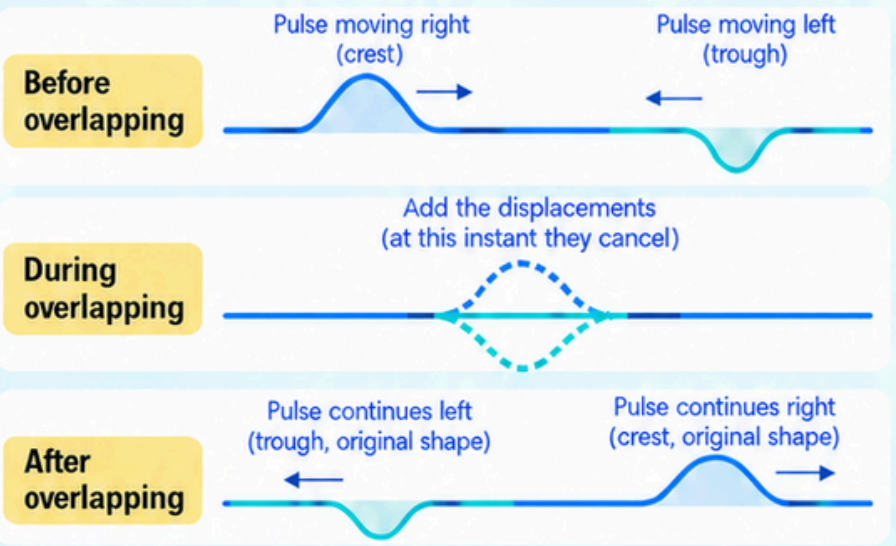
Waves arrive out of phase.
Crest meets trough.
Amplitudes subtract → weaker or zero signal.

Path difference = $(n - ½)\lambda$



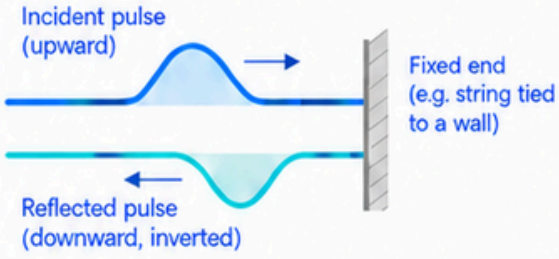
3 SUPERPOSITION

While pulses overlap, add their displacements.
After overlapping, each pulse continues with its original shape and direction.

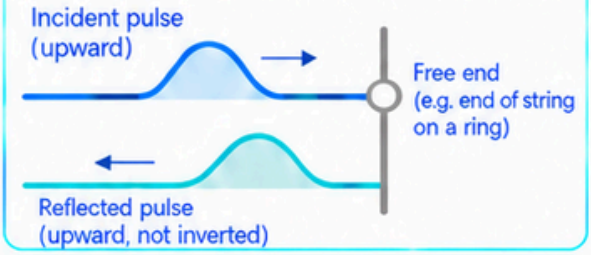


4 REFLECTED PULSES

Fixed end: pulse reflects inverted.

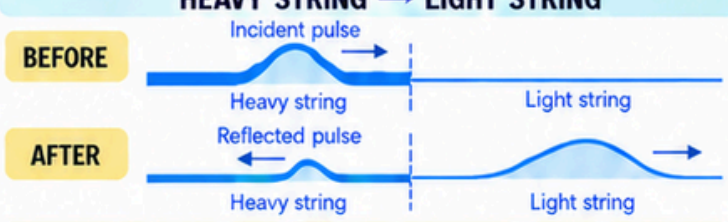


Free end: pulse reflects **without inversion.**



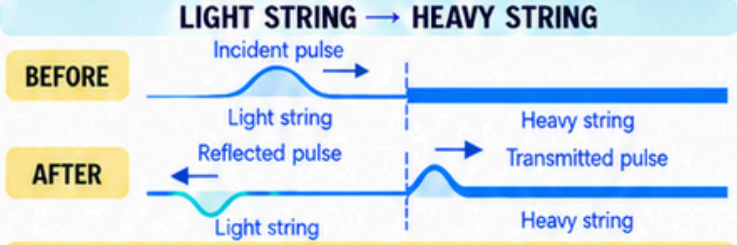
5 PULSES AT A STRING BOUNDARY

HEAVY STRING → LIGHT STRING



Reflected: upright. Transmitted: faster and wider.

LIGHT STRING → HEAVY STRING



Reflected: inverted. Transmitted: slower and narrower.