Waves

Reflection, Refraction, Diffraction, and Interference

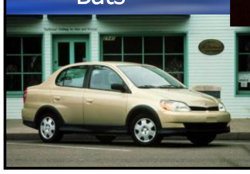
Objectives

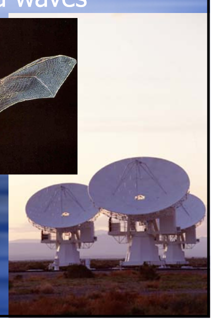
- Understand how water depth affects amplitude and wavelength
- Understand how media changes wave speed
- Recognize and describe the properties of:
  - Wave reflection
  - Wave refraction
  - Wave diffraction
  - Wave interference

Wave Reflection

Where have you experienced waves reflecting?

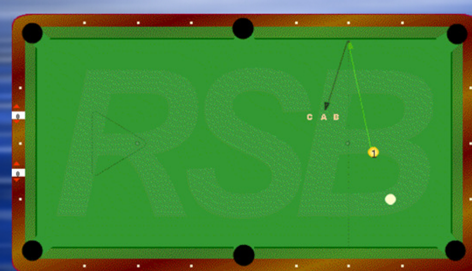
- Echoes
- Radio waves
- Bats





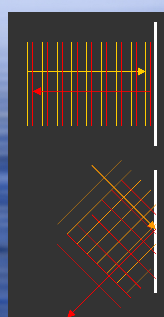
Wave Reflection

- Waves reflect like billiard (pool) balls

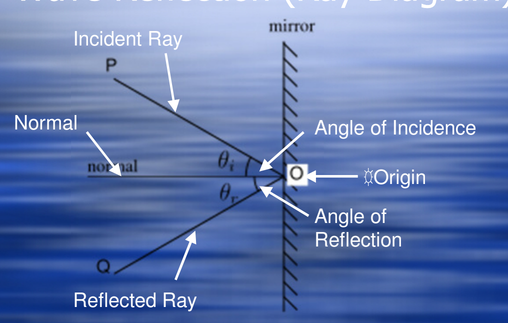


Wave Reflection

- Waves at right angles
- Waves at oblique angles



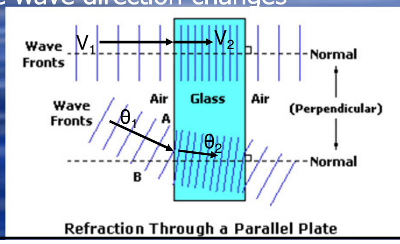
Wave Reflection (Ray Diagram)



Wave Refraction

When waves pass from 1 medium to another:

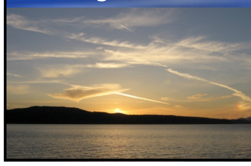
1. The wave velocity changes
2. The wave direction changes



Wave Refraction

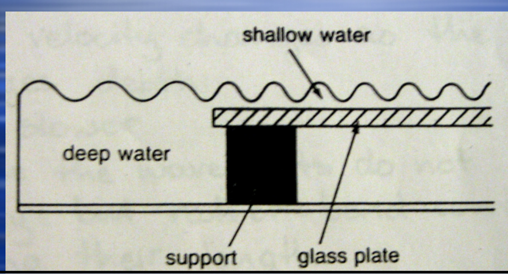
Where do waves move from one medium to another?

- Light from cold air to warm air
- Light from space to air
- Light from water to air



Wave Refraction

- Water passes from deep water to shallow water - Wavelength shortens



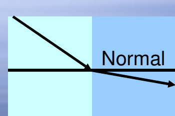
Wave Refraction

- No matter what the medium the frequency doesn't change:

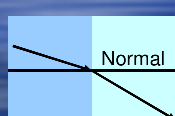
$f_1 = f_2$

Wave Refraction

- Oblique waves bend towards the normal when entering slower medium

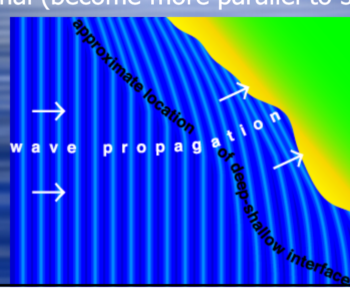


- Oblique waves bend away from the normal when entering faster medium

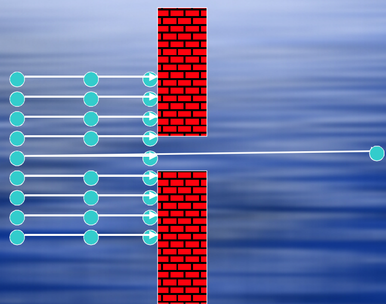


Wave Refraction

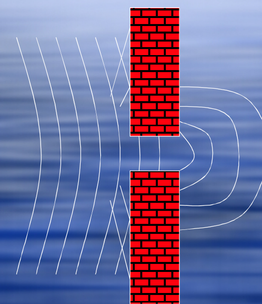
When waves enter shallow water (lower speed medium) they bend towards the normal (become more parallel to shore)



Wave Diffraction - Particles

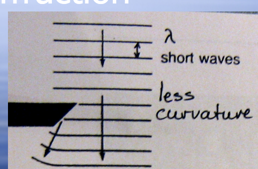


Wave Diffraction - Waves

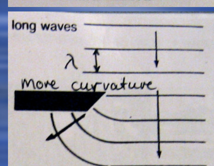


Wave Diffraction

- Shorter incident wavelengths are diffracted less



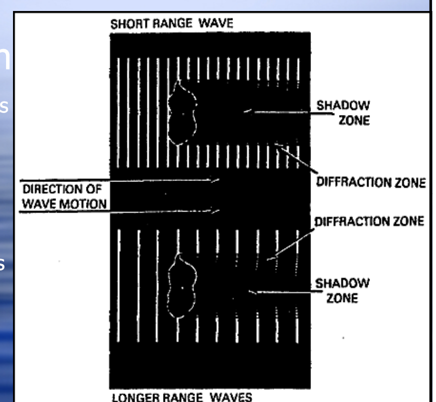
- Longer incident wavelengths are diffracted more



Wave Diffraction

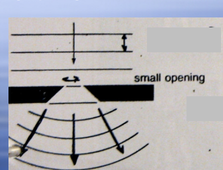
Short wavelengths diffract less around an object

Long wavelengths diffract more around an object

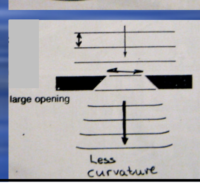


Wave Diffraction

- Waves passing through smaller openings are diffracted more



- Waves passing through larger openings are diffracted less



Wave Interference

- Waves rarely occur just by themselves
- Usually we have many waves occurring

Wave Interference

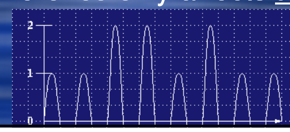
What happens when two waves meet one another?

- Bounce off each other?
- Die immediately?
- Pass through one another?
- Something else?

** The waves pass through one another, but create interference

Wave Interference

- Interference doesn't affect the individual waves
- Interference only affects the individual particles of the medium
- Interference only affects **amplitude**



Wave Interference

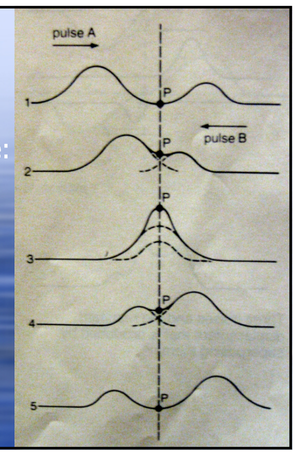
Constructive Interference:

- 2 waves with positive amplitude
- 2 waves with negative amplitude

Resulting wave amplitude will be larger than original wave amplitudes

Wave Interference

Constructive Interference:



Wave Interference

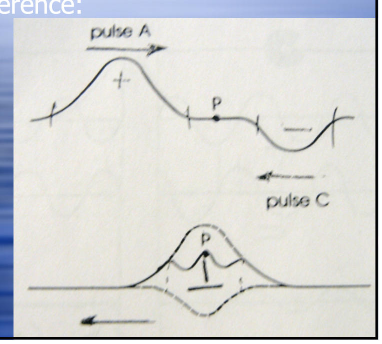
Destructive Interference:

- One positive amplitude wave, one negative amplitude wave

Resulting wave amplitude will be smaller than original wave amplitudes

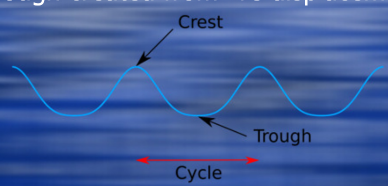
Wave Interference

Destructive Interference:



Principle of Superposition

- Wave amplitude = displacement of its individual particles from rest position
- Crest created from +ve displacement
- Trough created from -ve displacement



Principle of Superposition

Particle displacement of wave 1

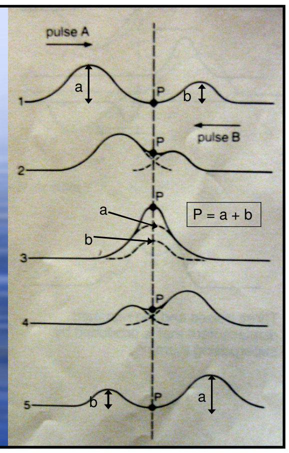
\+ Particle displacement of wave 2

Resultant particle displacement

Principle of Superposition

- Constructive Interference

$(\text{Wave amplitude})_P$ =
$(\text{Wave amplitude})_A$ +
$(\text{Wave amplitude})_B$

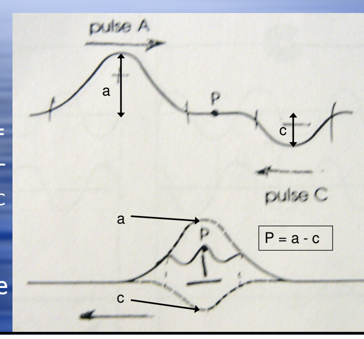


Principle of Superposition

- Destructive Interference

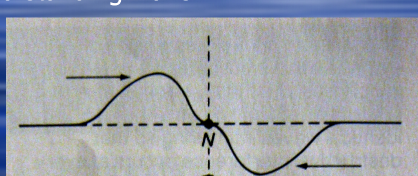
$(\text{Wave amplitude})_P$ =
$(\text{Wave amplitude})_A$ +
$(\text{Wave amplitude})_C$

But a trough has a negative amplitude



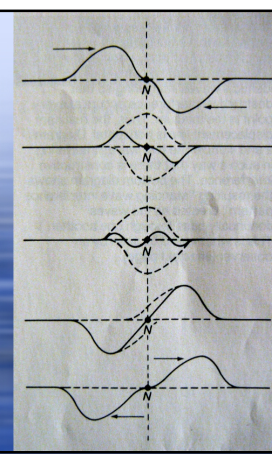
Standing Waves

- A special case of wave interference
- 2 waves (same wavelength/amplitude) traveling in opposite directions, creates a standing wave



Standing Waves

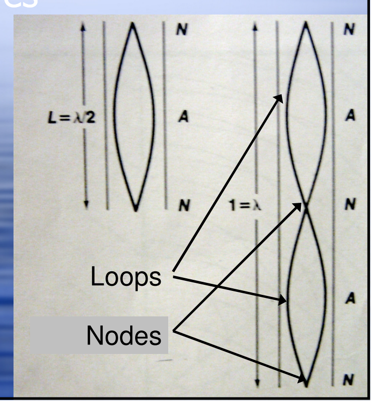
- When 2 like waves meet (Same A & λ), There is a point that never moves.
- This point is called a Node



Standing Wave

- Where do like waves (same A & λ) commonly meet?
- Standing waves are commonly found when a wave meets its reflection (Echo)
- Incident (A & λ) = Reflected (A & λ) but are headed in opposite directions

Standing Waves



Homework

- Reflection, Refraction, and Diffraction worksheet