Topic 5A:
Waves, Part II

Lecture:
Waves in the Ocean

How Waves Change as They Travel Across the Ocean and to the shore
Waves on Beaches: Wavelength

Wavelength gets **shorter** as waves approach a beach.

The wave crest closest to shore **slows downs**, because its orbitals “**feel the bottom**.”

The faster-moving wave crests farther from the shoreline begin to “catch up,” so distance between crests gets smaller.
Waves on Beaches: Height

As wavelength gets shorter (smaller), the water in a crest comes together (water in a crest is squeezed together). The water cannot go down: ocean bottom is in the way. The only direction that the water in a crest can go is up, so the wave height increases (wave grows taller).
The water that is spread out gets concentrated over a smaller distance as the wavelength is reduced, causing the water level to go up.
Wave “sets” & Misconceptions about wave growth
Waves almost always come almost straight towards a beach. Why?

Why don't waves ever go down the coast?

Why do waves always come directly into the beach?
Wave Refraction

Waves turn towards the coast as they approach the coast.
wave crests turn to *match* the shape of the shoreline
Refraction

A line of soldiers walks into the mud.

Soldiers on one end of the line move slower than soldiers at the other end.

They fall behind, causing their line to bend.
Waves slow down as they approach the coast, because their orbitals “feel the bottom.” The shallower the water, the slower the wave. The part of the wave crest in deeper water is moving faster, so it covers a greater distance and this swings the wave crest towards the shore.

**Key Idea:** One part of the wave crest is moving faster than another part.
Effects of Refraction

Refraction usually "stretches" wave crests:
Spreads Out Energy → Smaller

"Wave Shadow": Island has blocked the waves.

"Wrap Around" Effect

"Wave" Shadow

Waves can bend towards each other: Interfere → Higher

Headland
Waves May **Not** Completely Refract (Match the Shoreline) Before Breaking: Results in “Longshore Transport”

Longshore transport is the movement of *sand* down the shoreline. The sand is pushed by the *waves*.
Longshore Transport

- **Wave breaks** and water surges forward, up the beach *at an angle*.
- **Gravity** pulls the water & sand *straight back* down into the ocean.
- This happens again and again, so the sand slowly moves along the shoreline.

Longshore transport does *not* cause sand to move along the shoreline. LST *IS* the sand moving down the coast.
Describing Waves: Time

○ **period** = time “between” wave crests
  how long until the next wave crest passes by
  (e.g., a period of *time*)

○ **frequency** = how many waves pass by in a certain amount
  of time, how "often" waves pass by

**Important:** Period/Frequency do **not** change, even as waves approach a beach.
Animation: Period and Frequency

It takes the red ball 5 seconds to go from the trough to the crest and back down again, so the wave period is 5 seconds.

The ball will go up and down 12 times in a minute, so the frequency is $12/\text{minute} = 12/60 \text{ seconds} = 0.2 \text{ seconds}$. 

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Most Waves Are Made by the Strong Winds of Storms
Winds and Waves

The largest waves are made close to the Poles during Winter.

Wave Height

Significant wave height yearly mean (m)
Waves lose *very little* energy as they cross the ocean.

Remember: *Waves go through one another.*

Waves that meet may momentarily interfere & become steep enough to break (a little) and lose some energy.
As waves move away from the storm, their energy is spread over a wider & wider area.
long-wavelength waves get ahead of short-wavelength waves because they are faster

Wave period, wave speed, and wavelength do NOT change as waves travel across the ocean. (The ocean is so deep that orbitals do not touch the bottom & cause the waves to change.)
Wave Groups

Sea surface that results from the interference of waves of waves of 2 different wavelengths
Important ways in which waves effect the ocean and atmosphere

- Create Currents
- Send oxygen into air
- Take carbon dioxide out of the air
- Bring up nutrients and plankton