Chapter 11: Tides

The world’s largest tidal bore forms in China’s Qiantang River.
Waves – Question 1

Why does Hawaiʻi get some of the biggest waves? Why were waves so big this year?

Wave heights are dependent on:
1) Wind speed
2) Fetch
3) Wind duration

El Niño!
Question 2: Draw a wave and label its wavelength and height.

Wave 1
- Wavelength: 2 meters
- Wave height: 10 meters

Wave 2
- Wavelength: 6 meters
- Wave height: 8 meters
What are wavelengths and wave heights?

Additional examples:

A: Length: 4 meters
   Height: 6 meters

B: Length: 8 meters
   Height: 2 meters

C: Length: 12 meters
   Height: 4 meters

D: Length: 5 meters
   Height: 4 meters
Waves – Question 3

What makes a wave break?
Waves – Question 3

Wave approaching shore:

When wave ‘feels’ bottom, speed ↓ wave height ↑, wavelength ↓.

Wave becomes too steep and breaks.

Wave height increases because the wave’s energy is packed into less water depth.
### Types of Waves

All waves have a disturbing force and a restoring force.

<table>
<thead>
<tr>
<th>Wave Type</th>
<th>Disturbing Force</th>
<th>Typical Wavelength</th>
<th>Restoring Force</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capillary wave</td>
<td>Usually wind</td>
<td>Up to 1.73 cm (0.68 in.)</td>
<td>Cohesion of water molecules</td>
</tr>
<tr>
<td>Wind wave</td>
<td>Wind over ocean</td>
<td>60–150 m (200–500 ft)</td>
<td>Gravity</td>
</tr>
<tr>
<td>Seiche</td>
<td>Change in atmospheric pressure, storm surge, tsunami</td>
<td>Large, variable; a function of ocean basin size</td>
<td>Gravity</td>
</tr>
<tr>
<td>Seismic sea wave (tsunami)</td>
<td>Faulting of seafloor, volcanic eruption, landslide</td>
<td>200 km (125 mi)</td>
<td>Gravity</td>
</tr>
<tr>
<td>Tide</td>
<td>Gravitational attraction, rotation of Earth</td>
<td>Half Earth’s circumference</td>
<td>Gravity</td>
</tr>
</tbody>
</table>
Learning Goals: Tides

• Tides are periodic short-term changes in ocean surface height. They represent one type of wave:
  disturbing force = gravitational attraction + Earth’s rotation
  restoring force = gravity

• Tides are mainly created by gravitational attraction to the moon and the Sun. The relative locations of the Moon and the Sun create spring tides (highest) to neap tides (lowest) … and everything in between.

• There are three types of tidal patterns:
  1) Diurnal
  2) Semidiurnal
  3) Mixed

• There are also features called amphidromic points (where little to no tides occur).

Why? Think about this for next class.
The Benedictine abbey of Mont-Saint-Michel was built on a small, rocky, tidal island off the coast of Normandy, France. The Mount is connected to the mainland by a thin, natural land bridge that, until recently, was covered at high tide and exposed at low tide. Tides in the area vary greatly, sometimes reaching a difference of 14 meters (46 feet) between high and low water. Victor Hugo described high tides coming “as swiftly as a galloping horse.” Even today, visitors are occasionally drowned trying to walk to the abbey across the tidal flats.
The Moon’s gravity attracts the ocean toward it.

High tide – Earth’s side facing the Moon
Earth’s motion creates opposing dome on the other side, away from the Moon.

The Earth and Moon form a single system. The center of mass of this system is not at the center of the Earth, but closer to the Moon.
Combined result:

Moon
Low tide – regions water was taken to create high tides
Slack Water – region of no tidal currents (the tide is neither getting higher, nor getting lower)
The changing position of the moon relative to the Earth's equator produces relatively higher and lower high tides. Sometimes the moon is below the equator; sometimes it is above.
Tide chart for Monday – Miami Marina


“The lunar phase is a Waxing Gibbous.”
The moon’s phase indicates how strong the tides will be – why?
The Sun’s influence is not as strong as the Moon’s influence – but it makes a difference.

**Spring tides** – tides are amplified when Sun and Moon aligned.
Neap tides – tides reduced when Sun and Moon at right angles.
Full and New moons - Spring Tides.
Types of Tides

Diurnal tides –
1 high tide in 24 hrs.

Semidiurnal tides –
2 high tides in 24 hrs.

Mixed tides –
Combination
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Semidiurnal tides – 2 high tides in 24 hrs.

Mixed tides – Combination

What type of tides does South Florida experience?
Notice how at each of these places the surrounding color—the tidal force for that region—is blue, indicating little or no apparent tide. These convergent areas are called amphidromic points. Tide waves move around these points, **counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.**
Tides in the Bay of Fundy, Nova Scotia, are extreme because water in the bay naturally resonates (seiches) at the same frequency as the lunar tide.
Bay of Fundy: At the peak of the flood, water rises 1 meter (3.3 feet) in 23 minutes.