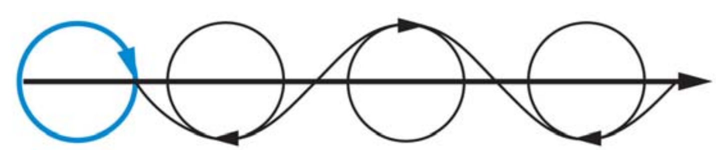
CHAPTER 8
Waves and Water Dynamics

- Wave Types (transmit energy not matter)
- Wave Terminology (the battle of the crests vs. troughs)
- Types of Ocean Waves (Deep vs. Shallow)
- Breakers (transitioning waves)
- Wave Refraction
- Tsunami

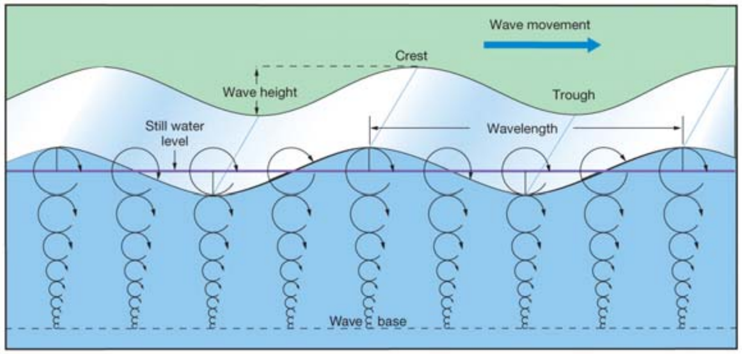
(1) LONGITUDINAL WAVE
Particles (color) move back and forth in direction of energy transmission. These waves transmit energy through all states of matter.

(2) TRANSVERSE WAVE
Particles (color) move back and forth at right angles to direction of energy transmission. These waves transmit energy only through solids.



(3) ORBITAL WAVE
Particles (color) move in orbital path. These waves transmit energy along interface between two fluids of different density (liquids and/or gases).

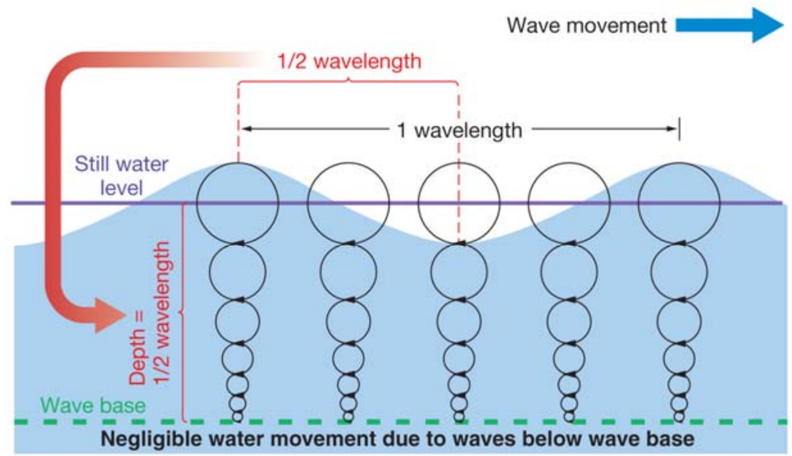
Orbital Waves



(a) Wave characteristics

- Crest vs. Trough
- Wavelength WH
- Wave height WL
- Wave Steepness = WH/WL

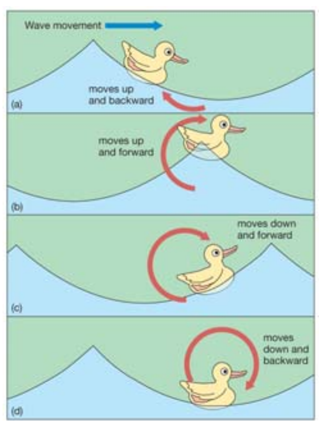
- **Frequency = 1/Period**
  <u>Frequency</u> = The number of wave crests that pass one location per unit of time.
  <u>Period</u> = The time required for 1 wave crest to pass one location.



(b) Calculation of wave base

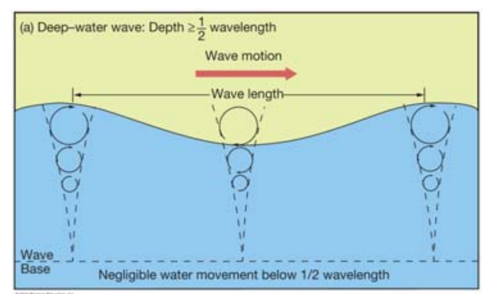
Circular Orbital Motion

- Wave particles move in a circle



Deep-Water Waves

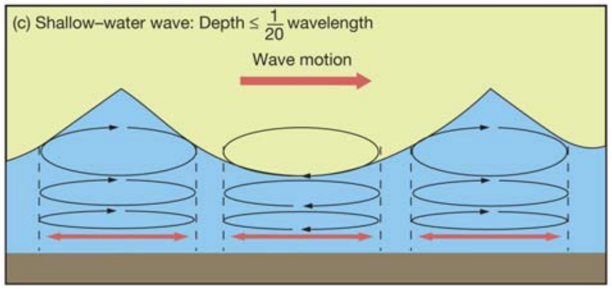
- No interference from the seafloor
  - Velocity (m/s) = 1.25 * $\sqrt{WL}\ (m)$
  - Velocity (m/s) = 1.56 * Period
  - Velocity (m/s) = WL/Period



Shallow-Water Waves

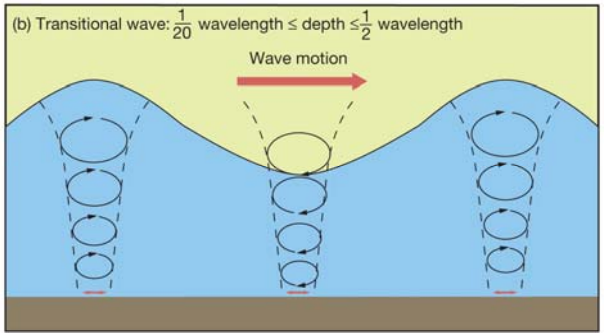
- Waves "feel" the sea floor.
- Water depth is ≤ ½ WL

Velocity (m/s) = 3.13 $\sqrt{d}$ (m)
d is water depth



Transitional Waves

- Characteristics of both deep- and shallow-water waves
- Velocity depends on both water depth and wavelength

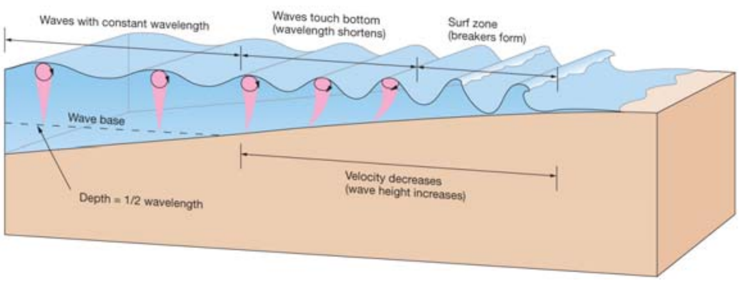


Waves Approaching Shore

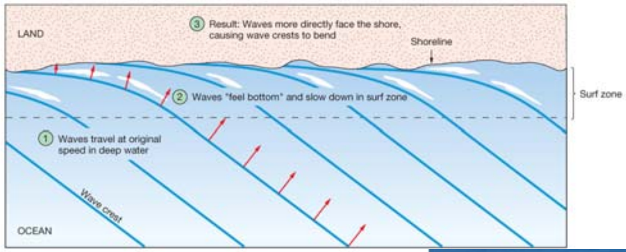
- As a deep-water wave becomes a shallow-water wave:
  - Wave speed decreases
  - Wavelength decreases
  - Wave height increases
  - Wave steepness (height/wavelength) increases
  - When steepness ≥ $^1/_7$, wave breaks

(or when the water depth $\leq 20 \ * WL$)

Waves Approaching Shore

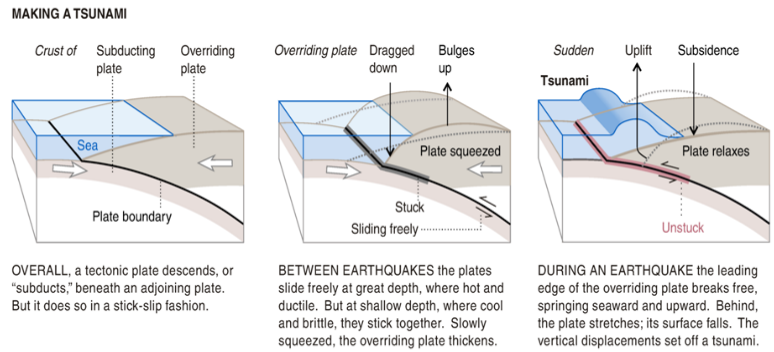


Wave Refraction

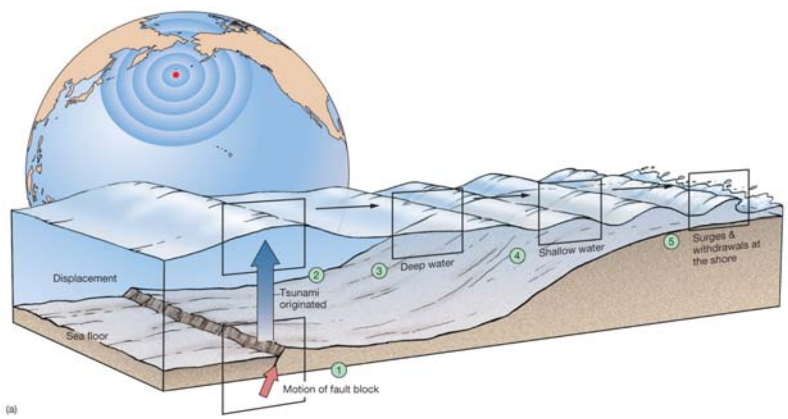


Ocean Continent Subduction

- **Subduction zone earthquakes can generate tsunami**



USGS



Ocean 10 Activity 6 10/12/12

Waves generally break when the water depth is less than 1/20 of the wavelength.

Use our knowidege of map scale, map distance, real world distance, and the geometry of breaking waves to calculate the depth of the water where these waves are first breaking.

(1) Measure the wavelength of these waves in five places. Mark these locations on the map and label them one through five. In the space below and on the back of this sheet of paper, convert these measurements to meters. Calculate the average (mean) of the measurements. Use waves that are easy to measure, close to the shoreline.

(2) Use your calculation for wavelength to determine the depth of the water where these waves are breaking (given the statement above from your textbook).

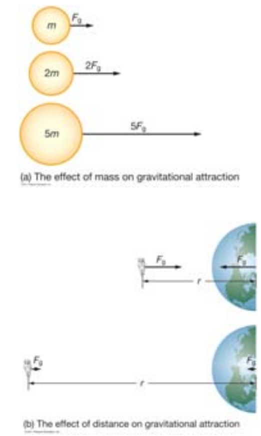
(3) Draw and label a depth contour on the map designating the depth you calculated in step 2.

CHAPTER 9
Tides

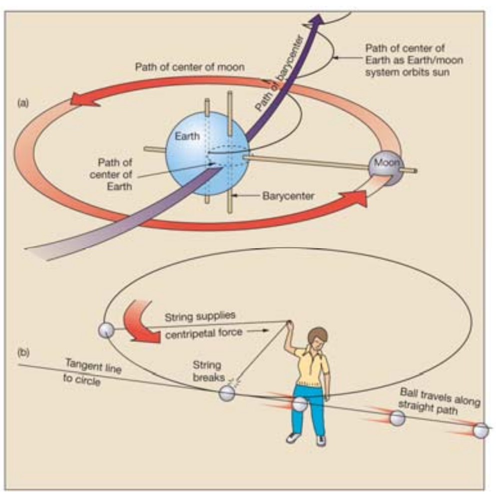
- Causes: Gravitational and Centripetal Forces
- Tidal Bulges: Lunar and Solar
- Idealized vs. Complicated Factors
- Idealized Tide Prediction
- How do tides vary globally?

Gravitational Force

$F_g = Gm_1m_2/r^2$

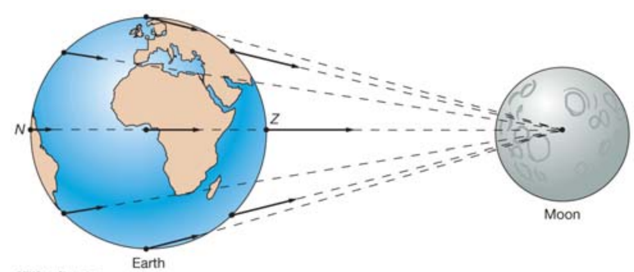


Centripetal Force



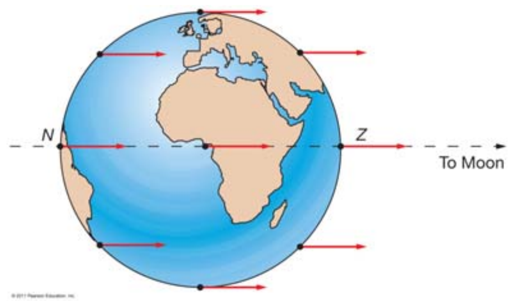
Gravitational Forces

- Greatest force at <u>zenith</u> – closest to moon
- Least force at <u>nadir</u> – furthest from moon and opposite zenith



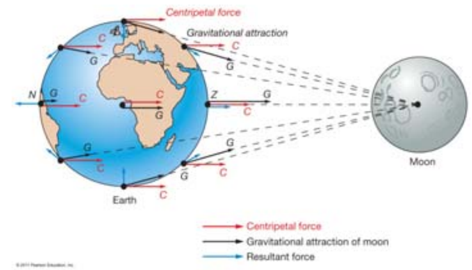
Centripetal Force

- Center-seeking force
- Tethers Earth and Moon to each other



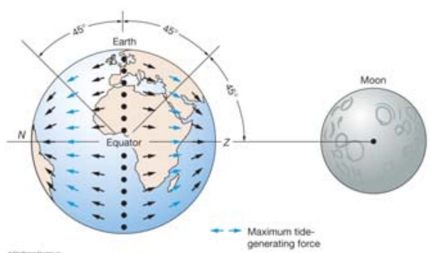
Resultant Forces

- Mathematical difference between gravitational and centripetal forces
- Relatively small

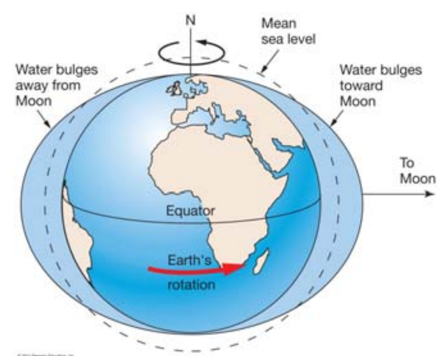


Tide-Generating Forces

- Resultant force has significant horizontal component
- Pushes water into two simultaneous bulges
  - One toward Moon
  - One away from Moon



Tidal Bulges – Moon’s Effect

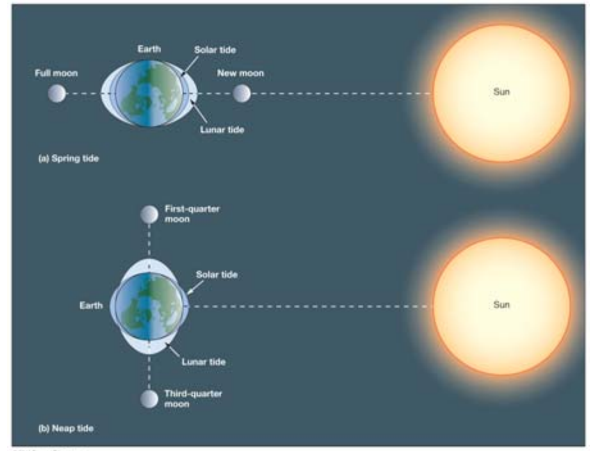


- Small horizontal forces push seawater into two bulges.
- Opposite sides of Earth

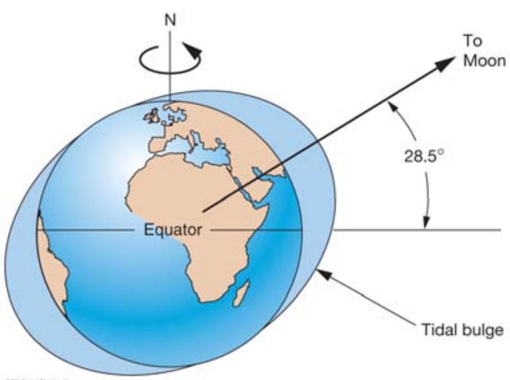
Earth's Rotation and Tides

- **Flood tide** – water moves toward shore
- **Ebb tide** – water moves away from shore
- Tidal bulges are fixed relative to the Sun's and Moon's positions
  - Earth's rotation moves different geographic locations into bulges

Earth, Moon, and Sun Positions Relative to Spring and Neap Tides

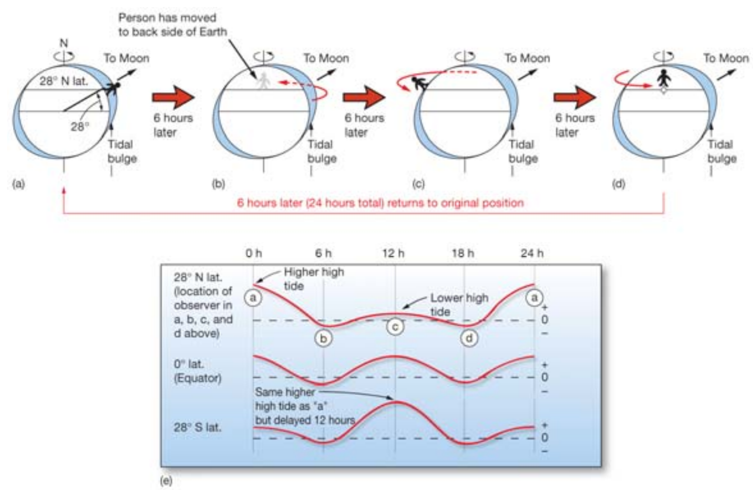


Declination and Tidal Bulges (Complicating Factors)

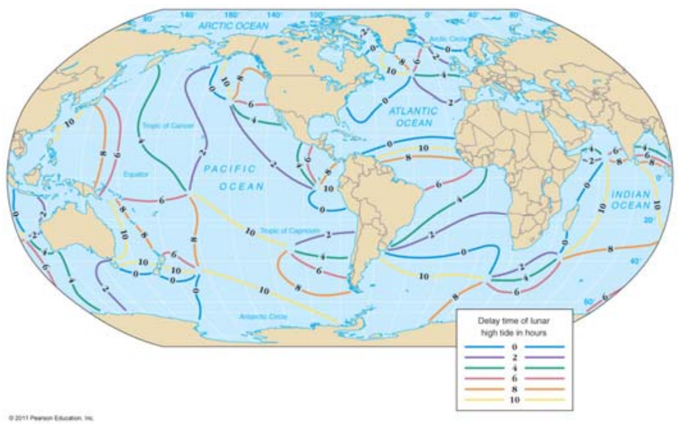


- Declination – Angular distance of the Moon or Sun above or below Earth's equator
- Sun to Earth: 23.5 degrees north or south of equator
- Moon to Earth: 28.5 degrees north or south of equator
- Lunar and solar bulges shift from equator
  - Unequal tides

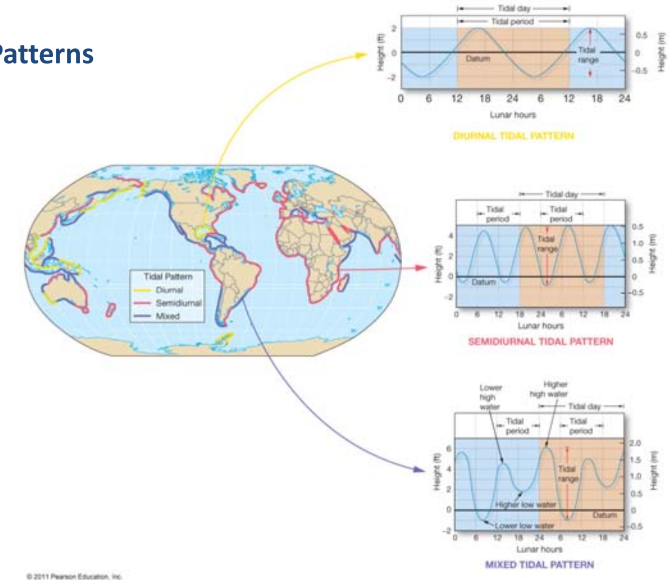
Predicted Idealized Tides



Cotidal Map (Complicating Factor)



Tidal Patterns



Monthly Tidal Curves

- Diurnal
  - One high tide/one low tide per day
- Semidiurnal
  - Two high tides/two low tides per day
  - Tidal range about same
- Mixed
  - Two high tides/two low tides per day
  - Tidal range different
  - Most common