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- 2  **Tides**
- 3  **Overview**
 - Rhythmic rise and fall of sea level
 - Very long and regular shallow-water waves
 - Caused by gravitational attraction of Sun, Moon, and Earth
- 4  **Barycenter**
 - Barycenter between Moon and Earth
 - Mutual orbit due to gravity and motion
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- 5  **Gravitational forces**
 - Every particle attracts every other particle
 - Gravitational force proportional to product of masses
 - Inversely proportional to square of separation distance
- 6  **Centripetal force**
 - Center-seeking force
 - Tethers Earth and Moon to each other
- 7  **Tide-producing forces**
 - Resultant forces = differences between centripetal and gravitational forces
 - Tide-generating forces are horizontal components
- 8  **Tidal bulges (lunar)**
 - Small horizontal forces push seawater into two bulges
 - Opposite sides of Earth
 - One bulge faces Moon
 - Other bulge opposite side Earth
- 9  **Tidal bulges (lunar)**
 - Moon closer to Earth so lunar tide-producing force greater than that of Sun
 - Ideal Earth covered by ocean
 - Two tidal bulges
 - Two high tides, 12 hours apart
 - High tide, flood tide, seawater moves on shore
 - Low tide, ebb tide, seawater moves offshore
- 10  **Lunar Day**
 - Moon orbits Earth
 - 24 hours 50 minutes for observer to see subsequent Moons directly overhead
 - High tides are 12 hours and 25 minutes apart
- 11  **Tidal bulges (solar)**
 - Similar to lunar bulges but much smaller
 - Moon closer to Earth
 - New/full moon – tidal range greatest – spring tide
 - Quarter moons – tidal range least – neap tide
 - Time between spring tides about two weeks
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- 12  **Earth-Moon-Sun positions & spring and neap tides**
- 13  **Tidal Cycle**
- 14  **Point Loma Tides**
- 15  **Other complicating factors: declination**
- 16  **Declination and tides**
 - Unequal tides (unequal tidal ranges)
- 17  **Other complicating factors: elliptical orbits**
- 18  **Idealized tide prediction**
 - Two high tides/two low tides per lunar day

- Six lunar hours between high and low tides
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- 18  **Real tides**
 - Earth not covered completely by ocean
 - Continents and friction with seafloor modify tidal bulges
 - Tides are shallow water waves with speed determined by depth of water
 - Tidal bulges cannot form (too slow)
 - Tidal cells rotate around amphidromic point
- 19  **Tidal cells in world ocean**
 - Cotidal lines
 - Tide wave rotates once in 12 hours
 - Counterclockwise in Northern Hemisphere
- 20 
- 21  **Tidal patterns**
 - 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
- 22  **Tides in coastal waters**
 - Standing waves
 - Tide waves reflected by coast
 - Amplification of tidal range
 - Example, Bay of Fundy maximum tidal range 17 m (56 ft)
- 23  **Tides in coastal waters**
 - Tidal bore in low-gradient rivers
- 24  **Coastal tidal currents**
 - Reversing current
 - Flood current
 - Ebb current
 - High velocity flow in restricted channels
- 25  **Coastal tidal currents**
 - Whirlpool
 - Rapidly spinning seawater
 - Restricted channel connecting two basins with different tidal cycles
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- 26  **Tides and marine life**
 - Tide pools and life
 - Grunion spawning
- 27  **Tide-generated power**
 - Renewable resource
 - Does not produce power on demand
 - Possible harmful environmental effects
- 28  **End of CHAPTER 9**
Tides