Hydrosphere - Oceanography

Ocean Waters
80% of
Southern Hemisphere
60% of
Northern Hemisphere
70% of Earth’s surface

1350 million km³ water
average depth ~4 km
deepest 11.5 km

Subdivided
Oceans
Pacific largest
1/3 Earth’s surface
Atlantic
most coastline
Indian
Arctic
Southern
Antarctic
Seas, Gulf, Bay, ...
Baltic, Mediterranean,
Red, Black, Bering ...

Source of Water (and atmosphere)
Degassing release of gaseous and volatile substances from solids and liquids during crystallization and pressure or heating.
Water Vapor originally caught in gaseous atmosphere condensed when cooled

SALT dissolved from land deposited in sea highly soluble
100 gm seawater ⇒ 3.5 gm NaCl
if oceans evaporate ⇒ 70 m salt
major ions (by weight)
Cl⁻ 55%  Na⁺ 31%
SO₄²⁻ 8%  Mg²⁺ 4%

Temperature of Oceans
reacts slowly to air temperature changes
Surface: -2°C near Poles 30°C near Equator
Deep Ocean: > 2km 1-3°C worldwide
  reservoir of cold water
Thermocline - region 1.2 - 1.4 km depth, T changes quickly

Ocean Floor
  continental
  shelf
  slope
  rise
  abyssal plane
  trenches
  deepest parts

Tides caused by Moon (and Sun) gravitational forces on Earth
  Force of gravity between two objects is mutual
  Newton’s 3rd Law of Motion:
    for every action, there is an equal and opposite reaction
    Forces always come in pairs!

Earth and Moon attract
  (pull on) each other
  Gravity is an inverse square law
  it gets weaker as the distance R between objects increases

Moon pulls on Earth’s near side (A)
  more than on Earth’s center (B)
  AND
Moon pulls on Earth’s far side (C)
  less than on Earth’s center (B)

Earth’s surface bulges toward and away from Moon
Earth’s oceans bulge more than the crust.

Earth rotates beneath Moon
  continents pass through ocean bulges.
  Ocean level rises every 12 hrs, falls 6 hrs later - Tides
  2 high tides and 2 low tides each day.

Sun also pulls on Earth
  less difference between opposite sides than Moon
Size of tides related to Earth-Moon-Sun position: Moon’s phase

At New Moon and Full Moon
  Solar and Lunar - same direction
  Spring tides: large tidal bulges do not only occur in spring!
At 1st and 3rd Quarter Moons
  Solar and Lunar - perpendicular

01-18a
Neap tides: small tidal bulges

Surprising consequences of tides:

1) Earth’s gravity causes tidal bulges in Moon
   friction in flexing Moon rock
   slowed Moon’s rotation
   rotation period = orbital period
   explains why Moon always keeps same face toward Earth

2) As Earth rotates, it pulls oceans against Moon’s gravity
   friction between oceans and crust slowed Earth’s rotation
   by 0.0023 sec/century
   900 million years ago the day was 18 hours long!
   tidal bulges are out of phase

3) Earth rotation drags ocean bulge ahead of Moon’s direction
   Gravity between ocean bulge and Moon is mutual
   Ocean bulge pulls Moon forward in its orbit
   causes Moon to recede from Earth by 4 cm/year