

I. Formation of Solar System

A. Nebular hypothesis

1. rotating cloud of gases and dust
2. collapses, heats to form Sun
3. cooling allows rocky elements to condense in inner
 - a. particles accrete to stony planets
 - b. small, warm, don't attract lighter gases
4. water, methane, ammonia, carbon dioxide are ices in outer disc
 - a. accumulate with rocky elements into large bodies
 - b. greater gravity allows retention of hydrogen and helium

B. 8 major planets

1. four inner stony, small
2. four outer gas giants
3. significant other bodies
 - a. asteroids
 - b. Kuiper-belt objects, which Pluto probably belongs
 - c. Miscellaneous dust, meteors, comets

II. Earth spheres

A. Three major spheres

1. atmosphere, thin envelope
2. hydrosphere covers more than 71% of surface
3. geosphere—from hydrosphere to center
4. Biosphere penetrates all three,
 - a. only thin zone
 - b. has created significant changes, especially to atmosphere
5. interaction has sculpted surface to what it is today

B. Geosphere can be divided by composition or physical properties

1. three compositional divisions
 - a. crust
 - 1) least dense, thinnest, coolest
 - 2) two types: continental and oceanic
 - a) oceanic ~7 km thick, basalt, 3 g/cm^3
 - b) continental ~40 km thick, granitic, 2.7 g/cm^3
 - b. mantle
 - 1) 2900 km depth
 - 2) Depleted in silica compared to crustal rocks
 - 3) Upper part has density $\sim 3.4 \text{ g/cm}^3$
 - c. Core
 - 1) Iron-nickel alloy
 - 2) 3480 km radius
 - 3) Density $\sim 13 \text{ g/cm}^3$
2. five divisions based on physical properties—(only one of these boundaries corresponds to composition boundary)

- a. lithosphere
 - 1) brittle, solid, broken into plates
 - 2) averages 100 km thick—from 5 to 250 km
 - 3) includes all of crust, and upper part of mantle
- b. asthenosphere
 - 1) almost at melting stage—
 - a) pressure keeps it from melting completely
 - b) release in pressure allows partial melting into magma
 - 2) weak compared to overlying lithosphere
 - 3) lithosphere moves around on this slushy upper mantle zone
 - 4) to depth of 660 km
- c. lower mantle
 - 1) increase in pressure increases strength
 - 2) solid, but capable of gradual flow
 - 3) 2240 km thick
 - 4) ends where liquid of outer core begins
- d. outer core
 - 1) molten metal flows to create Earth's magnetic field
 - 2) 2260 km thick
- e. inner core
 - 1) pressure makes it solid
 - 2) 1220 km radius

III. Nature of Earth's surface

- A. Lithosphere broken into plates that move over weak asthenosphere
 - 1. movement due to convection of heat from inner Earth to surface
 - 2. plates composed of crust and some mantle
 - 3. most plates have continental and oceanic crust on them
 - 4. interaction of edges where relative movement is apparent
 - a. divergent
 - 1) pressure release allows underlying asthenosphere to melt and fill in
 - 2) creates basaltic rock
 - b. convergent
 - 1) oceanic crust can be forced down into mantle--subducted
 - 2) plates carrying continental crust too buoyant to subduct
 - c. lateral ('transform') boundaries where plates slide past one another
- B. Features of ocean basins
 - 1. much is expansive flat areas—abyssal plains
 - 2. deep ocean trenches where sea floor is bent by subduction
 - a. narrow zones bordered by young mountain ranges
 - b. subduction creates uplift of these by generation of magma
 - 3. oceanic ridge system formed at divergent boundaries
 - a. broad, gentle uplift may or may not be in center of basin
 - b. interconnected to form largest volume of mountain range on Earth—70,000 km long

C. Features of continents

1. shoreline a coincidence of volume of ocean basin and amount of liquid water
 - a. actual boundary between oceanic basin and continents due to type of crust upon lithosphere plate
 - b. sea water laps up onto continental surfaces in zones of various widths
 - c. 40% of Earth's surface is continental, although about $\frac{1}{4}$ of this is covered with sea water at present
 2. Mountain belts rise high above average elevation of continents
 - a. Two major zones
 - 1) Circum-Pacific belt
 - 2) Alpine-Himalayan chain
 - b. Both result of lithospheric plate convergence
 3. continental shield composed of remnants of ancient mountain belts
 - a. folded crystalline rock
 - b. stable, not near lithosphere plate boundaries
 4. stable platform
 - a. has thin veneer of sedimentary rock deposited on them
 - b. may be only fundamental difference to shield
- IV. Earth is a system, with the spheres continually interacting
- A. Parts are linked, and action in one changes another
 - B. Cycles repeat motion over short or enormous lengths of time
 - C. Energy for system
 1. External—provided by Sun
 2. Internal—original heat of gravitational contraction, and by radioactive decay