

Chapter 5 Earth and Its Moon



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Units of Chapter 5

Earth and the Moon in Bulk

The Tides

Atmospheres

Interiors

Surface Activity on Earth

The Surface of the Moon

Magnetospheres

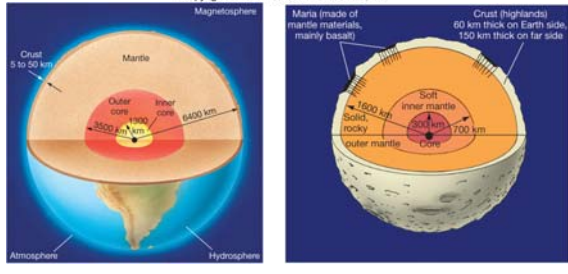
History of the Earth-Moon System

5.1 Earth and the Moon in Bulk

TABLE 5.1 Some Properties of Earth and the Moon

	MASS (kg)	MASS (Earth = 1)	RADIUS (km)	RADIUS (Earth = 1)	AVERAGE DENSITY (kg/m ³)	SURFACE GRAVITY (Earth = 1)	ESCAPE SPEED (km/s)	ROTATION PERIOD
Earth	6.0×10^{24}	1.00	6400	1.00	5500	1.00	11	23 ^h 56 ^m
Moon	7.3×10^{22}	0.012	1700	0.27	3300	0.17	2.4	27.3 days

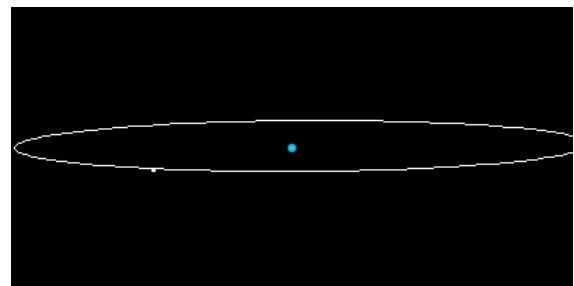
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Earth and Moon

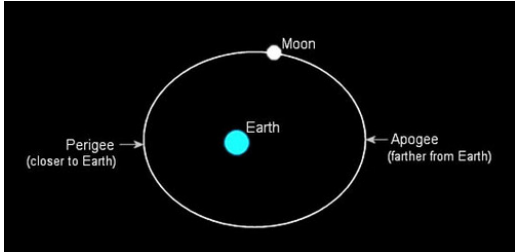
- Density - Mass per unit volume
 - On Average Earth is more dense, why?
- Gravity - Moon has less mass and thus less gravity - .17 earths gravity
- A person that weighed 100lbs. On earth would weigh 17 pounds on the moon.

- Escape Velocity - the speed required for any object (an atom, a baseball, or a spaceship) to escape forever from the body's gravitational pull
- Earth -11.2km/s
- Moon 2.4km/s
- ~25,000 miles per hour
- 1 km=.62 miles
- MPH of moon EV?



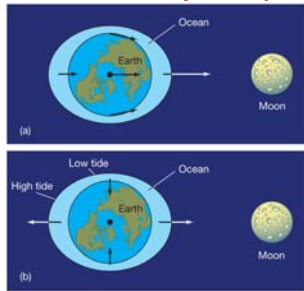
Apogee Perigee

- Perigee - 359861 km
- Apogee - 405948 km



5.2 The Tides

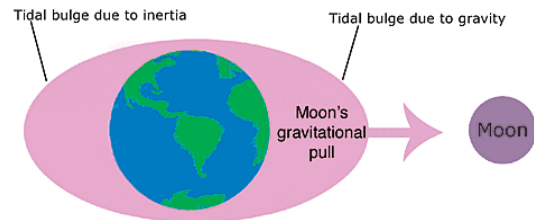
Tides are due to gravitational force on Earth from Moon – force on near side of Earth is greater than force on far side. Water can flow freely in response.



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Tidal Bulge - stretching of the ocean along the line joining Earth to the Moon

CENTRIPETAL FORCE - Causes bulge on both sides

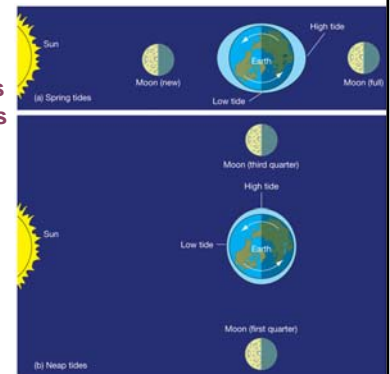


- Earth rotates through 2 high tides and 2 low tides per day



5.2 The Tides

The Sun has less effect, but it does modify the lunar tides:

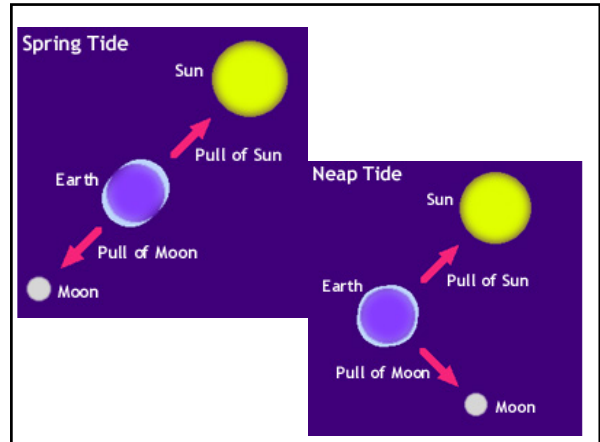


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Spring Tide and Neap Tides

Sun Moon and earth in align – Spring
Higher high and lower low tides

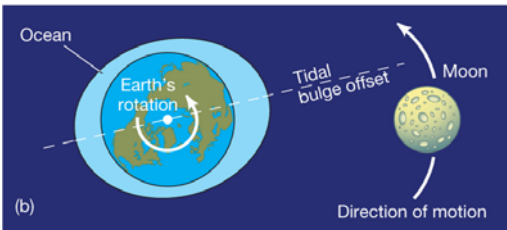
Moon Earth Sun at right angle – Neap
Lower high and higher low tides



5.2 Tidal Drag

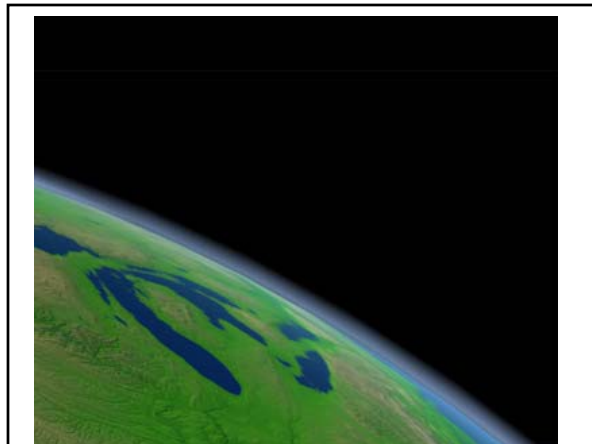
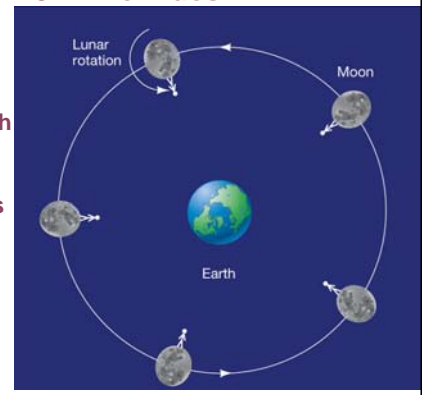
Tides tend to exert a “drag” force on the Earth,
slowing its rotation.

This will continue until the Earth rotates
synchronously with the Moon, so that the same
side of the Earth always points toward the Moon.



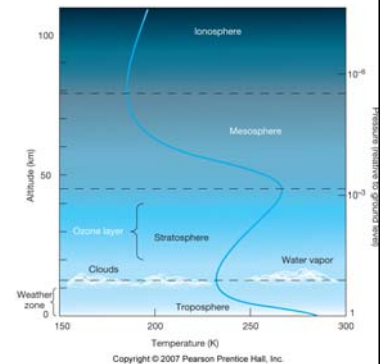
5.2 The Tides

This has
already
happened
with the
Moon,
whose
near
side is
always
towards
the
Earth.



5.3 Atmospheres

- The blue curve shows the temperature at each altitude
- Troposphere is where convection takes place – responsible for weather



5.3 Atmospheres

Convection depends on warming of ground by the Sun:



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5.3 Atmospheres

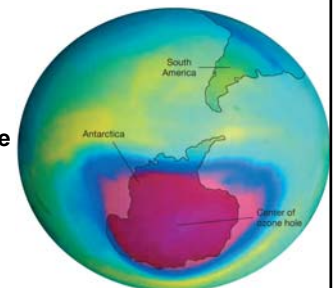
Ionosphere is ionized by solar radiation, and is good conductor

Reflects **radio waves** in the AM range, but transparent to FM and TV

Ozone layer is between ionosphere and mesosphere; absorbs **ultraviolet radiation**

Discovery 5-1: Earth's Growing Ozone Hole

Chlorofluorocarbons (CFCs) have been damaging the ozone layer, resulting in **ozone hole**:



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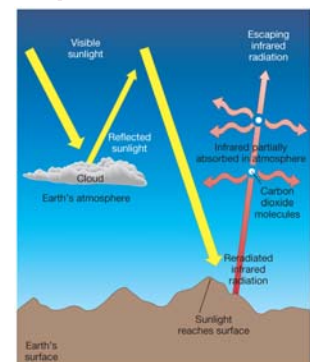
5.3 Atmospheres

Surface Heating:

- Sunlight that is not reflected is absorbed by Earth's surface, warming it
- Surface re-radiates as infrared thermal radiation
- Atmosphere absorbs some infrared, causing further heating

5.3 Atmospheres

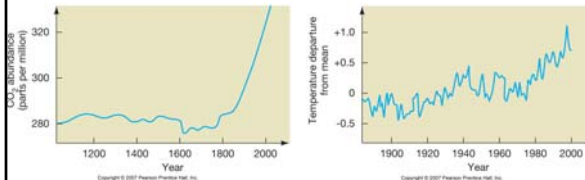
This is known as the **greenhouse effect**:



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Discovery 5-2: The Greenhouse Effect and Global Warming

There is extremely strong evidence that the Earth is getting warmer. The cause of this warming is a subject of intense debate; many scientists believe it is related to the corresponding increase in atmospheric carbon dioxide.



5.4 Interiors

Seismic waves:

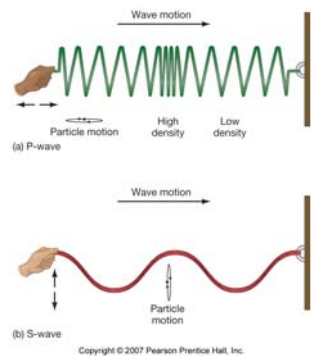
- **Earthquakes** produce both pressure and shear waves
- **Pressure waves** will travel through both liquids and solids
- **Shear waves** will not travel through liquid, as liquids do not resist shear forces
- **Wave speed** depends on density of material

5.4 Interiors

pressure wave is longitudinal

shear wave is transverse

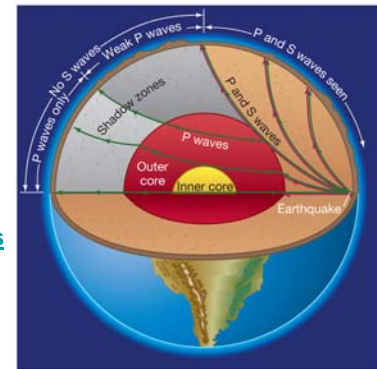
shear cannot propagate within a liquid.



5.4 Interiors

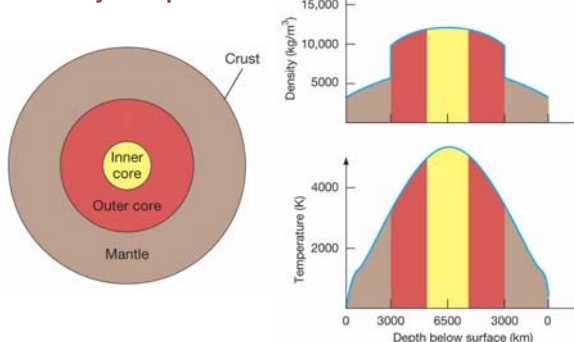
use pattern of reflections from earthquakes to deduce interior structure of Earth

[Seismic eruptions](#)



5.4 Interiors

Currently accepted model:



5.4 Interiors

Mantle is much less **dense** than core

Mantle is rocky; core is **metallic** – iron and nickel

Outer core is **liquid**; inner core is **solid**, due to pressure

Volcanic **lava** comes from mantle, allows analysis of composition

5.5 Surface Activity on Earth

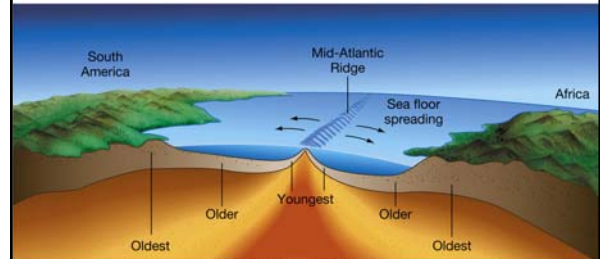
Continental drift: Entire Earth's surface is covered with crustal plates, which can move independently. At plate boundaries, get earthquakes and volcanoes:



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5.5 Surface Activity on Earth

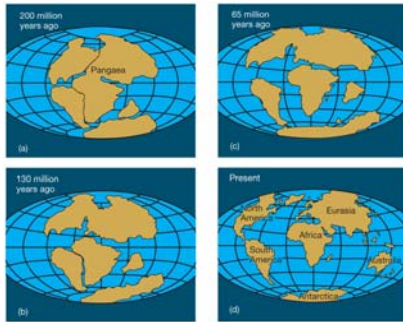
Plates moving away from each other create rifts:



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5.5 Surface Activity on Earth

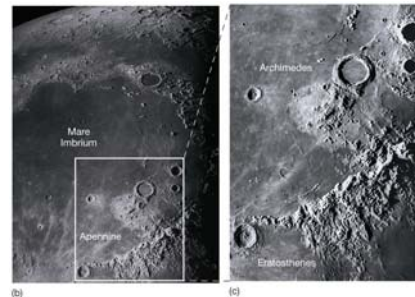
If we follow the continental drift backwards, the continents merge into one, called **Pangaea**:



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5.6 The Surface of the Moon

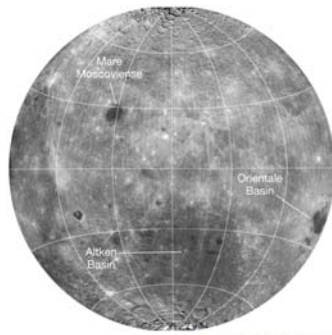
Moon has large dark flat areas, due to **lava flow**, called **maria** (early observers thought they were oceans):



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5.6 The Surface of the Moon

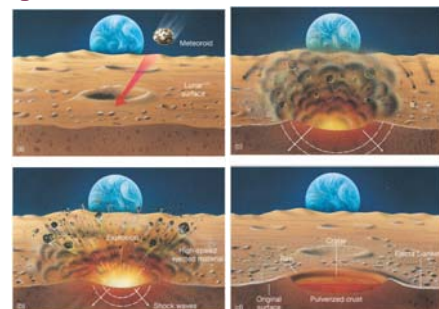
The far side of the Moon is relatively unmarked:



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5.6 The Surface of the Moon

Crater formation: Meteoroid strikes Moon, ejecting material; explosion ejects more material, leaving crater

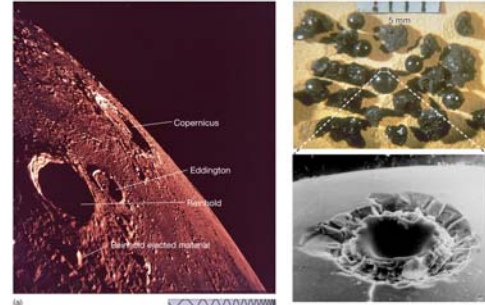


5.6 The Surface of the Moon

- Craters are typically about 10 times as wide as the meteoroid creating them, and twice as deep.
- Rock is pulverized to a much greater depth.
- Most lunar craters date to at least 3.9 billion years ago; much less bombardment since then.

5.6 The Surface of the Moon

Very large and very small lunar craters:



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5.6 The Surface of the Moon

Regolith: thick layer of dust left by meteorite impacts

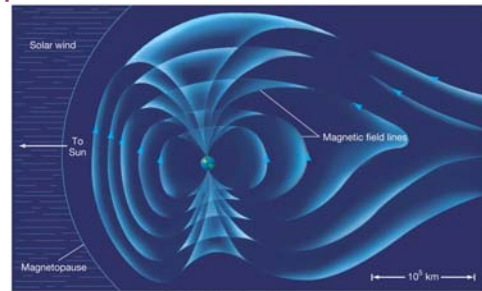
Moon is still being bombarded, especially by very small “micrometeoroids”; softens features:



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5.7 Magnetospheres

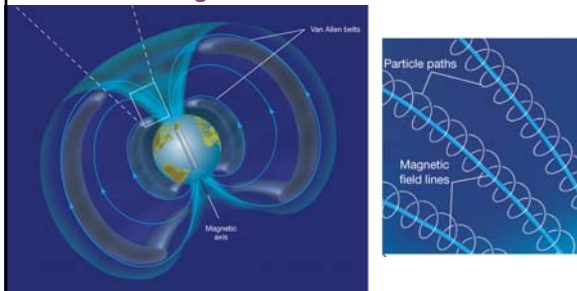
The **magnetosphere** is the region around the Earth where charged particles from the solar wind are trapped:



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5.7 Magnetospheres

These charged particles are trapped in areas called the **Van Allen belts**, where they spiral around the magnetic field lines:



5.7 Magnetospheres

Near the poles, the Van Allen belts intersect the atmosphere. The charged particles can escape; when they do, they create glowing light called an **aurora**:



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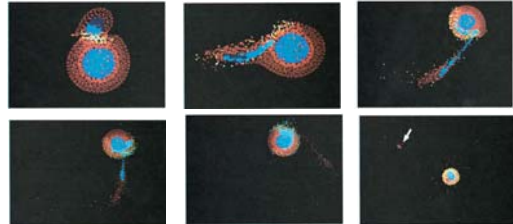


Animation

5.8 History of the Earth-Moon System

Current theory of **Moon's origin**: glancing impact of Mars-sized body on the still-liquid Earth caused enough material, mostly from the mantle, to be ejected to form the Moon.

Computer model:



5.8 History of the Earth-Moon System

4 billion years ago, the Moon had many craters but no maria. By 3 billion years ago, the maria had formed. Now, they also are covered with craters.



(a) 4 billion years ago

(b) 3 billion years ago

(c) Today

Summary of Chapter 5

- Earth's structure, from inside out:
Core, mantle, crust, hydrosphere, atmosphere, magnetosphere
- Tides are caused by gravitational effects of Moon and Sun
- Atmosphere is mostly nitrogen and oxygen; thins rapidly with increasing altitude
- Greenhouse effect keeps Earth warmer than it would otherwise be

Summary of Chapter 5

- Study interior by studying seismic waves
- Crust is made of plates that move independently
- Movement at plate boundaries can cause earthquakes, volcanic activity, mountain ranges, and rifts
- New crust formed at rifts shows evidence of magnetic field reversals
- Earth's magnetic field traps charged particles from solar wind

Summary of Chapter 5

- Main surface features on Moon: maria, highlands
- Heavily cratered
- No atmosphere and large day–night temperature excursions
- Tidal interactions responsible for synchronicity of Moon's orbit

Summary of Chapter 5

- Moon's surface has both rocky and dusty material
- Evidence for volcanic activity
- Moon apparently formed as a result of a large object colliding with the Earth