

Physics 311, Fall 2008

Review II

4. Our Solar System (Chap7, Lecture Notes)

4.1-4.3 Structure of the Solar System

- a. Must know the names of all planets, their relative distances from the Sun, and members in the two categories of planets.
- b. Must know how terrestrial planets are different from Jovian planets: the relative size, mass, average density, composition etc.
- c. Must know how Pluto is different from other planets: why Pluto does not fit either category.
- d. Must know which planets have satellites.
- e. Know the seven largest satellites in the solar system, their names, their parent planets, relative size, mass, average density, composition, presence of atmosphere.
- f. Must know what are asteroids and comets, where they are found, and how asteroids are different from comets.
- g. Must know Kepler's third law: $P^2 = a^3$. Must know the units in the formula. Must know to which solar system objects Kepler's third law can be applied to calculate the orbit distance or period.

4.4 Presence of Atmosphere – Escape Speed and Thermal Speed

- a. Must know what factors determine whether a certain gas can be present in the atmosphere of a planet or satellite. Must be able to reason why certain planets have an appreciable atmosphere while others do not.
- b. Must know the concepts of average thermal speed and escape speed and be able to use the thumb rule to find out whether a certain gas is retained in the atmosphere.

Average thermal speed of a gas at temperature T is:

$$v_{th} = \left(\frac{3kT}{m} \right)^{1/2}$$

m = mass of a gas particle (kg); T = temperature (K=kelvins);

v_{th} = average thermal velocity (m/sec); k = Boltzmann constant = 1.38×10^{-23} J/K

Escape speed at the surface of a planet:

$$v_{esc} = \left(\frac{2GM}{R} \right)^{1/2}$$

M = mass of the planet (kg); R = radius of the planet(m);

G = gravitational constant = 6.67×10^{-11} N m²/kg².

Example: why molecular oxygen gas, but not hydrogen gas, stays in the Earth's atmosphere.

Example: comparing capabilities of Earth and the Moon to retain a certain gas.

4.5 Composition

- a. Must know how to estimate the average density.

- b. Must know how to estimate roughly the composition of planets and satellites from their average density.

Note: Average density of water = 1000 kg/m^3

Average density of rock = 3000 kg/m^3

Average density of metal (e.g.iron) = $13,000 \text{ kg/m}^3$

- c. Must know how the surface and atmosphere compositions can be determined more accurately (also reveal Lecture 2).

Example: how do we know that methane, but not H or O_2 , is dominant in Titan's atmosphere.

Example: Europa's surface composition

4.6 Cratering and Age

- a. Know how craters are formed.
- b. Know how we can estimate roughly the age of the surface by the number of craters.
- c. Know how geological activities affect the number of craters.

4.7 Magnetic Fields

- a. Know which planets have global magnetic fields.
- b. Must know what causes a planet to have a strong magnetic field – what is dynamo.
- c. Know how the mechanisms of dynamo are different in terrestrial planets and Jovian planets.

Other: know how to determine properties of planets: orbit size, orbit period, diameter, mass, density, composition, magnetic field, internal structure.

5. The Living Earth (Chap 9, Lecture Notes)

5.1 Earth's Activity, Energy, and Greenhouse Effect

- a. Must know what are the energy sources to drive various activities on the Earth: motion of water, motion of atmosphere, reshaping of the surface, and life.
- b. Must know the nature of tidal force and what effects it produces on the Earth.
- c. Greenhouse effect:
 - Must know how Earth's incoming and outgoing energies are balanced.
 - Must know the dominant wavelengths of solar radiation and Earth's radiation.
 - Must know the concept of albedo (reflectance).
 - Must be able to calculate the theoretical mean surface temperature of Earth (see your homework problem).
 - Must know what is the greenhouse effect, how it affects the Earth's surface temperature, and why such effect on temperature is critical.
 - Must know what gases are greenhouse gases.
 - Understand what might be the consequence of human-caused greenhouse effect in the past century.

5.2 The Earth's Atmosphere

- a. Must know the composition of the Earth's atmosphere, and how it is different from atmospheres of other terrestrial planets.
- b. Know the history and evolution of the Earth's atmosphere.
- c. Must know the stratification of the atmosphere, the temperature profile of each layer, and why so.
- d. Must know how the Earth's atmosphere protects us from short-wavelength solar radiation.
- e. Know major circulation patterns in the Earth's atmosphere, and the major mechanisms causing these patterns.

5.3 The Earth's Internal Structure

- a. Must know the layered structure of the Earth's interior, and how it formed.
- b. Know relative size, density, and rough composition of different layers: inner core, outer core, mantle, and crust.
- c. Must understand why the outer core is liquid while the inner core is solid.
- d. Understand how seismic waves produced in earthquakes are used to diagnose the interior structure of the Earth.
- e. Must know the proofs that the Earth has a liquid core.

5.4 Plate Tectonics

- a. Know what is a Pangaea, the idea of continent drift, and geological proofs.
- b. Must know the concepts of plate tectonics and how it works. Must know the concepts of lithosphere, asthenosphere, subduction.
- c. Must know what (energy source) drives plate tectonics, and be able to reason what factors lead to plate tectonics.
- d. Must know how major geological features, mountain ranges, earthquakes, gulfs, etc., are produced due to plate tectonics, and where significant geological activities (like volcanoes and earthquakes) are located.
Example: geographic location of the Everest and its continuous growth.

5.5 The Earth's Magnetosphere

- a. Must know how the Earth's magnetic field is generated (also see Lecture 4), and how the shape of the magnetosphere is affected by solar wind.
- b. Must know the particle radiation belt - the Van Allen Belt, and how it is formed.
- c. Know how the Earth's magnetosphere protects life on Earth.
- d. Must understand how aurorae are produced and why they are usually seen in polar regions.
Example: dramatic auroral display after some violent solar coronal mass ejection events.
- e. Understand what is space weather, the origin of space weather, and how we may forecast space weather.

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