

Chapter 3 Study Guide and Case Studies: The Solar System and the Layered Earth

Key Concepts

- The universe contains a large number of galaxies that in turn contain a large number of solar systems. Our Solar System has a sun, eight planets, five dwarf planets, asteroids, comets and other celestial bodies. The universe is about 14 billion years old, while Earth is about 4.5 billion years old.
- A unit used in astronomy to describe distances in the Solar System is the astronomical unit, the equivalent of the mean Sun-Earth distance ($1 \text{ AU} = 1.496 \times 10^8 \text{ km}$ or 149.6 million km). For larger distances outside the Solar System, the light year is used, the distance that light travels in one Earth year: $1 \text{ ly} = 10 \times 10^{12} \text{ km}$ or 10 trillion km).
- The Solar System is home of two types of planets. The terrestrial planets (or inner planets, or rocky planets) and the Gas Giants (or outer planets). The planets formed from the solar nebula through the process of accretion, first into planetesimals, then into proto-planets, then into planets.
- Planets develop a layers structure through differentiation where the heavier element sink toward the center and the light elements rise to the surface.
- Earth has a powerful magnetic field that is sustain by a dynamo. The field protects Earth's surface from the harmful solar wind.
- The Moon formed in Earth's early history when a Mars-size body struck the still soft but already differentiated Earth.
- Although Venus is often called Earth's sister, this planet has no surface water. A dense CO_2 atmosphere is responsible for a runaway greenhouse. Plate tectonics resurfaces the entire planet catastrophically.
- Mars has a thin atmosphere but nevertheless strong winds. They cause dust storms observable from Earth.
- Jupiter has four large moons, the Galilean moons, each one with very distinct features that resemble processes on Earth.
- Pluto's small size relative to other bodies, its extremely elliptic orbit and a relatively large Moon, Charon, make this former planet a unique oddity in the Solar System.
- Apart from Pluto, asteroid Ceres and 3 trans-neptunian objects (Eris, Haumea and Makemake) are dwarf planets.
- The asteroid belt between Mars and Jupiter is located where another planet should have formed. Asteroids can have Mars-crossing or even Earth-crossing orbits and are therefore potential impactors.

- Comets are low-density “dirty snowballs” consisting of cosmic dust embedded in an icy crust. Upon approaching the Sun, gases and dust are expelled to form the coma and a dust tail. Comets originate from the Oort Cloud or the Kuiper Belt.
- Meteorites are remnants found on Earth’s surface after a meteoroid impacted. Iron meteorites are thought to resemble Earth’s iron core, while stony meteorites are thought to resemble Earth’s mantle.
- The impact of a meteoroid produces immense instantaneous pressure and temperature that allows the formation of shatter cones beneath the impact crater, shocked quartz and tektites. Large impacts also distribute iridium around the globe, an element not common on Earth’s surface. Soot found in clay layers is evidence for immense wildfires after an impact.
- Earth has a solid inner core, a liquid outer core, a stiff mesosphere, a weak, soft asthenosphere and a strong, brittle lithosphere.
- The lithosphere floats on the asthenosphere where the balance of the gravitational force and the buoyancy force hold the lithosphere in isostatic equilibrium. Glacial growth and the construction of reservoirs disturbs this equilibrium, causing the asthenosphere to react. The lithosphere sinks during glaciation. It rises after an ice age during post-glacial rebound.

Key Terms

- Galaxy
- Solar System
- terrestrial planets
- gas giants
- Galilean satellites
- ecliptic
- sidereal period
- retrograde rotation
- synchronous rotation
- dynamo
- TNO
- dwarf planets
- asteroids
- comets
- nucleus
- coma
- bolide
- meteor
- shooting star
- meteoroid
- meteorite
- meteor shower
- chondrites
- shocked quartz
- tektites
- NEO
- NEA
- Torino Scale
- Moho discontinuity
- crust
- mantle
- core
- lithosphere
- asthenosphere
- isostasy
- glaciation
- post-glacial rebound

Questions for Review

1. How old are Earth, the Solar System and the Universe?
2. What is the difference between a galaxy and a solar system?
3. How did the planets in our Solar System form?
4. Describe the two main categories of planets in the Solar System.
5. Why was Pluto downgraded to a dwarf planet in 2006?
6. What distinguishes a dwarf planet from a real planet?
7. What other Solar System bodies are currently dwarf planets?
8. What may explain the existence of the Asteroid Belt?
9. What is the difference between an asteroid and a comet?
10. Describe the main features of a comet?
11. What is a meteor?
12. What are the principal types of meteorites?
13. How can we distinguish a volcano crater from an impact crater?
14. What defines a near-Earth object?
15. Describe how the hazard level of a NEO is determined in the Torino Scale.
16. What are the principal layers inside Earth?
17. What distinguishes the inner core from the outer core?
18. Which forces play a role in the concept of isostasy?
19. What is the lithosphere composed of?
20. Why is the continental lithosphere thicker than the oceanic lithosphere?
21. Describe the concept of post-glacial rebound.