Homework 4

Chapter 6, Q3, 7

3. What are the four major features of our solar system that provide clues to how it formed? Describe each one briefly.

7. List the four categories of materials in the solar nebula by their condensation properties and abundance. Which ingredients are present in terrestrial planets? In jovian planets? Explain why.

Chapter 7, Q3, 8

3. Why do large planets retain internal heat longer than smaller planets? Briefly explain how internal heat is related to mantle convection and lithospheric thickness.

8. What does the greenhouse effect do to a planet? Explain the role of greenhouse gases and describe the basic mechanism of the greenhouse effect.

Chapter 8, Q3, 5

3. Briefly describe the interior structure of Jupiter and why it is layered in this way. How do the interiors of the other jovian planets compare to Jupiter?

5. Briefly describe Jupiter’s cloud layers. How do the cloud layers help explain Jupiter’s colors? Why are Saturn’s colors more subdued? Why are Uranus and Neptune blue?

Hydrostatic Equilibrium:

Review the discussion on page 259-60 of the text (next two pages) on "The Stable Sun" and answer questions below:

What is hydrostatic equilibrium?
How does it apply to the atmosphere of the Earth?
How does hydrostatic equilibrium differ between the Earth, Jupiter and the Sun?
The Stable Sun  Nuclear fusion requires extremely high temperatures and densities (for reasons we will discuss in the next section). In the Sun, these conditions are found deep in the core. Thus, for the Sun to shine steadily, it must have a way of keeping the core hot and dense. It maintains these internal conditions through a natural balance between two competing forces: gravity pulling inward and pressure pushing outward. This balance is called gravitational equilibrium (or hydrostatic equilibrium).

A stack of acrobats provides a simple example of gravitational equilibrium (Figure 10.1).

![Figure 10.1](image)

An acrobat stack is in gravitational equilibrium: The lowest person supports the most weight and feels the greatest pressure, and the overlying weight and underlying pressure decrease for those higher up.

The bottom person supports the weight of everybody above him, so his arms must push upward with enough pressure to support all this weight. At each higher level, the overlying weight is less, so it’s a little easier for each additional person to hold up the rest of the stack.

Everywhere inside the Sun, the outward push of pressure balances the inward pull of gravity.

Gravitational equilibrium works much the same in the Sun, except the outward push against gravity comes from internal gas pressure rather than an acrobat’s arms. The Sun’s internal pressure precisely balances gravity at every point within it, thereby keeping the Sun stable in size.

![Figure 10.2](image)

Gravitational equilibrium in the Sun: At each point inside, the pressure pushing outward balances the weight of the overlying layers.
Because the weight of overlying layers is greater as we look deeper into the Sun, the pressure must increase with depth. Deep in the Sun’s core, the pressure makes the gas hot and dense enough to sustain nuclear fusion. The energy released by fusion, in turn, heats the gas and thus generates pressure that keeps the Sun in balance against the inward pull of gravity.

Earth’s atmosphere is also in gravitational equilibrium, with the weight of upper layers supported by the pressure in lower layers. Use this idea to explain why the air gets thinner at higher altitudes.