

MODELING PLANETARY INTERIORS AND DIFFERENTIATION

Grades:

9-12

Duration:

45 minutes

Materials:

For the group:

- Various materials that are insoluble and of different densities (e.g., fish gravel, marbles, straws, plastic beads, wooden beads, Legos, etc.)
- Light colored, non-toxic liquids of different densities (e.g., cooking oil, syrup, corn syrup, water, etc.)

For each team:

- 1 clean plastic bottle with lid and no label (1/2 liter to 2 liter)
- Markers
- Rulers
- Planetary Interior Data Table

OVERVIEW —

The students model the interior structure of the terrestrial planets and the process of differentiation using solids and liquids of different densities.

OBJECTIVE —

The students will:

- Compare and contrast the interior structures of different terrestrial planets
- Develop an understanding of the process of differentiation that results in the layered geometry within the terrestrial planets.

ACTIVITY —

Using the table of planetary interior data, challenge the students to work together as teams to create **working** models of the interiors of the terrestrial planets and the Moon using the materials provided.

Have different teams work on different planets to make a cross-section “in a bottle.” The models should be able to differentiate (be shaken and settle into the different layers).

Once the models are created, invite each team to share their model and then have the group compare and contrast the differences in the planetary interiors.

In what way do the models “work” – reflect natural conditions and processes?

In what ways do the models not represent natural conditions and processes?

BACKGROUND —

All of the terrestrial planets became hot as they formed, from the constant pummeling by impactors as it accreted, and from the radioactive decay of elements. Very soon after formation, the planets' interiors melted or partially melted, and the materials reorganized.

The terrestrial planets are made of primarily the same materials—silicates and metals—but in different amounts. The denser elements in each planet — iron and iron sulfide — separated from the more silicate-rich materials and sank to the interior, a core; this process created even more heat as these materials came to a sudden halt. The silicate-enriched layer surrounding the core formed the mantle. The least dense silicate materials formed the crust, perhaps crystallizing from a magma ocean that enveloped the planet.

This differentiation is no longer occurring in the Moon and Mercury; it might still be happening inside of Mars and Venus, and is definitely happening on Earth, as evidenced by volcanic activity.

We haven't seen any of the planets' interiors. On Earth, we have samples of the crust and upper mantle; seismic and gravity data help us to sort out the layers. On remote planets, we use gravitational surveys from spacecraft to help inform our models of their interiors.

The conditions of most other planets' cores are uncertain. Other planets may have inner and outer cores. Some, such as Mercury, appear to have molten cores. More data are needed.

TIES TO STANDARDS —

Earth and Space Science

Science Process Skills: Modeling

C.5(B) Investigate the sources of heat, including kinetic heat of impact accretion, gravitational compression, and radioactive decay, which allow layers of a protoplanet to differentiate and become a planet as Earth did 4.6 billion years ago.

C.5(E) Compare the four terrestrial planets to the four gas giant planets in the solar system, including internal structure, atmosphere, size, density, solar orbit, presence of water, surface features, tectonic activity, temperature, and suitability for life.

Planetary Interior Data Table

Planet	Radius (Km)	Inner Core Thickness (Km)	Outer Core Thickness (Km)	Mantle (Km)	Crust (Km) Thickness
Mercury	2440	75% of the radius			Ranges 100-300
Mercury Bottle Calculations					
Venus	6052	3000			~100
Venus Bottle Calculations					
Earth	6371	From 5100-6378	From 2890-5100	From 35-2890	Ranges 5 to 50
Earth Bottle Calculations					
Moon	1737	350			50
Moon Bottle Calculations					
Mars	3 396	1480			Ranges 35 to 80
Moon Bottle Calculations					

Based on the bottle size, calculate how much of the bottle will be filled by core (inner and outer if information is available) mantle, and crust for the planet you choose.

Select materials that will differentiate appropriately; when shaken and then allowed to stand still, the core, mantle, and crust should differentiate so that the crust is on the top, the mantle is in the middle, and the core is on the bottom of the bottle.

What “works” and what does “not work” on your model?

Planet:

	Chemical Composition	Physical and Mechanical Properties	Thickness (radius of planet)
Inner Core			
Outer Core			
Mantle			
Crust			

