

Looking Inside Planets

Middle/high school grades

Lesson Summary

Students will make scale models of the interiors of the nine planets and compare them. They will see that the structures of the four inner planets are similar to each other, as the structures of the four giant planets. They will discover that the giant planets have rocky cores that are similar in size to the Earth and Venus.

Prior Knowledge & Skills

- General astronomy
- Understanding of scale models

AAAS Science Benchmarks

The Physical Setting

The Earth

NSES Science Standards

- **Physical Science:** Properties and changes of properties in matter
- **Earth and Space Science:** Structure of the Earth system

NCTM National Mathematics Standards

- **Measurement:** Apply appropriate techniques, tools, and formulas to determine measurements
- **Number and Operations:** Compute fluently and make reasonable estimates

Suggested background reading

How Did the Solar System Form?

Teaching Time: One 45-minute period

Materials

Each group needs:

- Planetary Interior Data Table
- Poster board, white
- Ruler
- Compass or pencil on string
- Colored pencils or markers
- Cotton balls
- Small bubble wrap
- Sand or sandpaper
- Aluminum foil

Advanced Planning

Preparation Time: 30 minutes

1. Collect art materials
2. Review the lesson plan

Science context

The planets are divided into two groups: the inner planets, which are small and rocky, and the outer planets, which are large and gaseous. (Tiny, rocky Pluto is an anomaly.) Scientists believe that in the rotating “protoplanetary disk” of the early solar system, chunks of debris collided with neighboring chunks to form baby planets big enough to attract debris gravitationally. Far from the sun, this rotation swept out more material, growing larger planets in our solar system’s far reaches. These giant planets grew big enough to gravitationally attract gas as well as the more dense material that makes up the inner planets.

Source: ARES NASA Johnson Space Center

LASP

Lesson 3: Looking Inside Planets

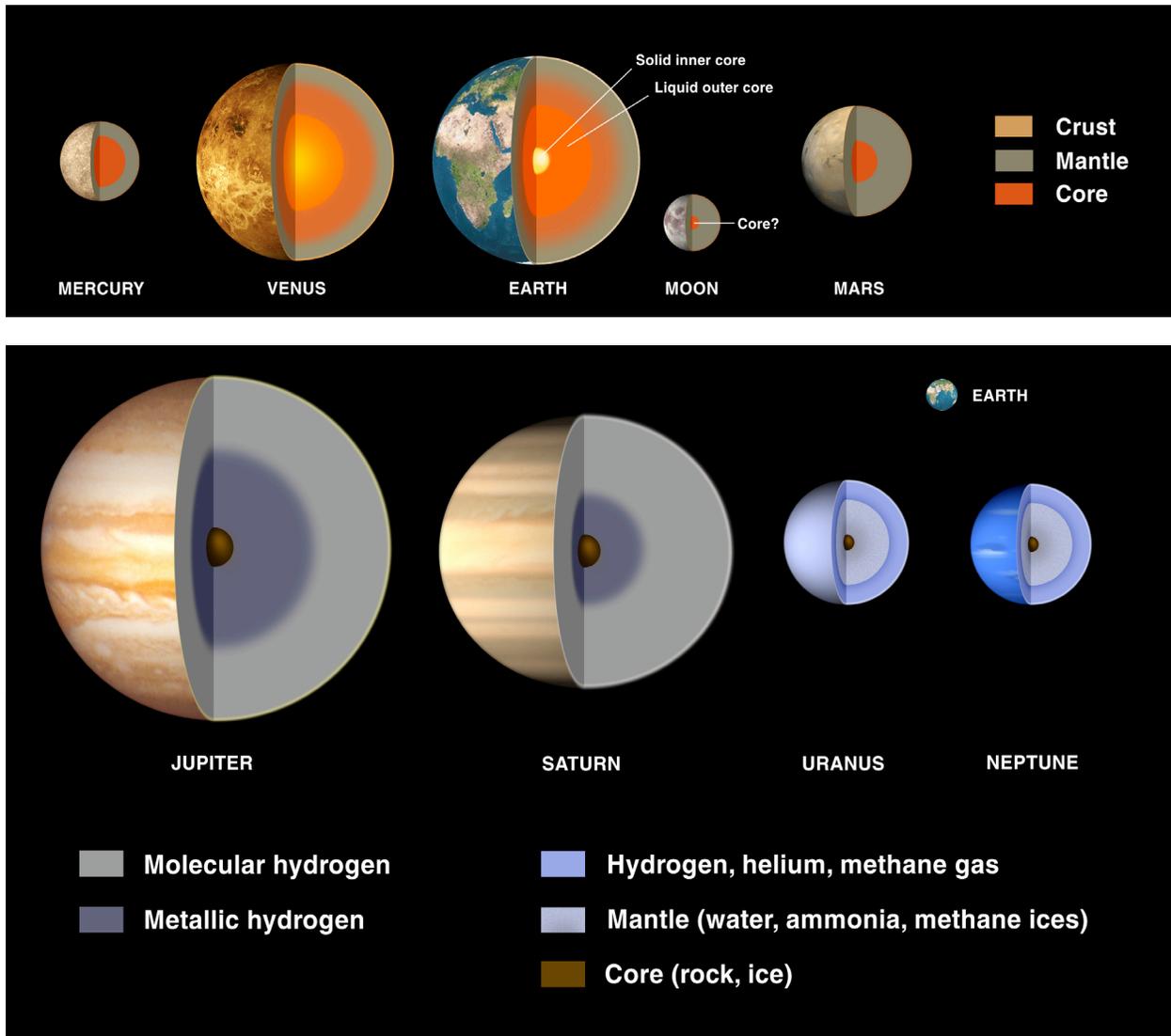


Figure 3. Top - Interiors and compositions of the terrestrial planets and the Moon. Bottom - Interiors and compositions of the giant planets. The two drawings are at different size scales as seen from the size of Earth on the bottom figure. Neither figure represents an accurate distance scale. Credit LPI.

Objective: Students will make scale models of the interiors of the nine planets and compare them. They will see that the structures of the four inner planets are similar to each other, as the structures of the four giant planets. They will discover that the giant planets have rocky cores that are similar in size to the Earth and Venus.

Background:

The planets are divided into the inner planets which are small and rocky, the outer planets which are large and gaseous, and Pluto which is the smallest, most distant, and anomalous.

Comparisons within the groups of four inner terrestrial planets or four outer gas giants show strong similarities in composition and internal structure within each group and very strong contrasts with the other group. However, it is fascinating to note that the inner rocky cores of Jupiter and Saturn are near to the sizes of the Earth and Venus. These differences are caused by variations in temperature and gravity during the formation of the planets.

Materials:

for each group
Planetary Interior Data table art materials to glue on board
poster board, white cotton balls (atmosphere)
ruler small bubble wrap (ice/liquid)
compass or pencil on string sand or sandpaper (rock)
colored pencils or markers OR Al foil (metal)

Procedure:

Teacher Preparation: Decide whether to use colors or art materials to represent different layers inside planets. Collect materials.

Classroom Procedure:

- 1) Divide the class into 6 to 10 groups. Distribute Planet Interiors data table and assign each group a planet to model. If there are 6-8 groups, omit planets having others of like size (Venus, Saturn, Neptune). For 10 groups, add the Moon. Gather materials.
- 2) Using a scale of 1 cm = 1000 km, draw a circle on the poster board with a radius the size of the planet. This represents the planet's surface. For the smaller planets use a compass. For the giant planets use the pencil on a string. Jupiter and Saturn are too big to fit on the poster board. Draw 1/4 Jupiter and 1/2 Saturn.
- 3) Draw an inner circle with a radius the size of the core and another circle for the interior.
- 4) Draw an outer circle with a width the size of the atmosphere (0-2 cm).
- 5) Fill in the circles with colors or glued art materials to represent the composition and state of the layers.
- 6) Line up the planet models in astronomical order so that students may compare them. Have students describe the size, internal layers, and composition of their planets.
- 7) Conduct a discussion that compares the inner planets with the outer planets and reasons for variations in size and composition. Consider distance from the sun and likely temperature differences.

Planetary Interiors Data

(radii in K km)

Planet	Atmosphere Radius	Atmosphere Composition	Surface Radius	Surface Composition	Interior Radius	Interior Composition	Core Radius	Core Composition
Mercury		none	2.44	rock	??	rock	1.7	metallic iron
Venus	6.5	gas carbon dioxide	6.1	rock	6.0	rock	3.0	metallic iron
Earth	7.4	gas nitrogen, oxygen	6.4	rock (water)	6.3	rock	3.5	metallic iron
Mars	3.6	gas carbon dioxide	3.4	rock (ice)	3.3	rock	1.7	metallic iron
Jupiter	71.8	gas hydrogen, helium	71.5	gas-liquid hydrogen, helium	70/55	metallic hydrogen	15.0	rock, ice*
Saturn	60.6	gas hydrogen, helium	60.3	gas-liquid hydrogen, helium	50/30	metallic hydrogen	16.0	rock, ice*
Uranus	27.2	gas hydrogen, helium	25.5	liquid hydrogen, helium, methane	18	ice water, methane, ammonia	1.0	rock*
Neptune	25.2	gas hydrogen, helium	24.7	liquid hydrogen, helium, methane	19	ice water, methane, ammonia	1.0	rock*
Pluto		none	1.17	Rock, methane ice	??	rock		??

* The deep interiors of the 4 giant planets are very similar in composition and diameter, consisting of 15-19 K km of rock and ice, most likely with more rock in the core and more ice farther out. The compositions of the near-mid interiors differ significantly due to size and pressure.