Densities of the Planets (for students)

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Background: The planets of the solar system are each different from one another. However, these eight planets can be separated into two families based on several of their properties. One of the most powerful properties is density. It will tell us what material a planet is made up of.

Q: What is density?
A: It is an object's mass divided by the volume of space it takes up. This expresses how compacted (high density) or how fluffy (low density) it is. For example, a rock has a high density, and a pillow has a small density.

Q: How can we determine the mass of a planet far away?
A: We look at the orbit of one of its moons. The mass of the planet produces gravity, and this gravity controls the orbit of each of the planet's moons.
Mass is measured in kilograms or in grams. (1 kg = _____ g)

Q: How can we determine the volume of a planet far away?
A: We can measure its radius R with a telescope. We assume that it is a sphere and calculate its volume as

Volume of sphere =

If the radius is in kilometers then the volume will be in km^3.

If the radius is in meters then the volume will be in _____

If the radius is in centimeters then the volume will be in cm^3 or milliliters, since 1 cm^3 is the same as 1 ml.

How many cubic meters is 1 ml?

Once we know a planet's mass and its volume we can calculate the planet's density by dividing its mass by its volume.

Here are the results:

Planet	Density (grams/milliliter)
Mercury	5.43
Venus	5.25
Earth	5.52
Mars	3.95
Jupiter	1.33
Saturn	0.69
Uranus	1.29
Neptune	1.64

Draw a number line and mark the density numbers by a planet's initial.

Can you see the two families? (Y / N) Circle each family on the number line.

Family 1 contains planets _____

Family 2 contains planets _____

The astronomical name for family 1 is _____

The astronomical name for family 2 is _____

Using a model of planet densities

Consider a big piece of cheese. It has a certain density. Now consider breaking off a small chunk of the cheese. What is its density (smaller, same, larger)?
This concept allows us to easily make a small model of a huge planet.

Checking the Model:

For each planet, calculate what the canister would have to weigh to have its known density.

Planet	Density (grams/milliliter)	Mass of model canister (g)	Is the model OK?
Mercury	5.43		
Venus	5.25		
Earth	5.52		
Mars	3.95		
Jupiter	1.33		
Saturn	0.69		
Uranus	1.29		
Neptune	1.64		

Put one canister on the balance. Does it weigh what you calculated? Try all the planets.

Interpretation:

1. Relative densities
   a) Feel the canisters in your hands. Can you distinguish the two planet families without looking at the names?

   b) Can you arrange the planets in order of density without looking? Check with the number line you made earlier.

2. Floating and sinking
   Water has a density of 1 g/ml.
   If a material has a density larger than 1, it sinks like a stone.
   If a material has a density of less than 1 it floats in water.
   Are there any planets which would float in water? _____

3. Types of materials
   a) Densities above 3 grams/ml tell us that their material is made of rock, that is, silicates and irons. Which planets are rocky?
   _____
   b) Densities about 1 g/ml are gas or ice or water. Which planets are gaseous or ice?
   _____

Get a transparent bucket with water in it. Put the canisters in one by one and watch them sink fast, sink slow, or float. Was it what you expected?