Densities of the Planets (for teachers)

M.L. West and K. Sieminska

Note: there is a shorter version of this activity for students to do.

NJCCCS: 5.3.8.A.1, 5.3.8.B.1, 5.3.8.D.1, 5.9.8.B.1, 4.1.8.A.1, 4.5.8.B.2, 4.5.8.C.3

Equipment: 8 film canisters, masking tape, scissors, waterproof pen, calculators, balance, lead sinkers and lead beads, tape for sealing (electrical or package), large soda bottle, box cutter

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

Q: What is density?
A:

Q: How can we determine the mass of a planet far away?
A:

Mass is measured in kilograms or in grams. (1 kg = _____ g)

Q: How can we determine the volume of a planet far away?
A:

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.

Once we know a planet's mass and its volume we can calculate the planet's density by dividing its mass by its volume. Why do we choose to use the units of grams/ml for densities of planets?

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 _____

Constructing 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 compared to the big piece? (smaller, same, larger)
This concept allows us to easily make a small model of a huge planet.

Method:

1. Cut small pieces of masking tape to mark the planet's names on. Stick one of these markers on the bottom of each of the canisters.

2. Weigh 5 canisters. Calculate the average weight. _____ (Should be about 5 grams.)

Volume of canister: 39 milliliters = 39 ml

If a canister weighed 39 grams, what would its density be? _____

If a canister weighed 2 x 39 grams = _____ grams, what would its density be? _____

If a canister weighed 5.43 x 39 grams = _____ grams, what would its density be? _____

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)	#3 size sinkers	#1 size sinkers
Mercury	5.43			
Venus	5.25			
Earth	5.52			
Mars	3.95			
Jupiter	1.33			
Saturn	0.69			
Uranus	1.29			
Neptune	1.64			

Note that you should use the large sinkers first. For each of the four most dense planets you will need to begin with #3 size sinkers and their top loops which were cut off so that they could fit into the canisters. Remember to include the heads!
Put a plastic canister top and a canister on the balance and add the required number of lead sinkers. Set the balance for the model weight. Slowly add lead beads until the canister and its top reaches that weight.
Cap the canister tightly. Seal the canister with electrical tape or package tape. Lead dust is toxic.

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.

    (Why do you think this is difficult?)

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?

      _____

   c) Using a box cutter or large scissors, cut a 2 liter soft drink bottle in half horizontally below its shoulders. (Or get a transparent bucket or pitcher.)
      Put about 10 cm of water in the "bucket."
      Put the canisters into the water one by one and watch them sink fast, sink slow, or float.
      Was it what you expected?

Extensions: Have students look up planet radii, then calculate volumes.
Using the known densities, calculate the planet masses. Check and discuss why they are not quite the same as the masses they look up.

Source of materials: Newark Sinker Co., 101 Rt. 46 East, Montville, NJ, near Bloomfield Ave.