The Playdoh Universe: Relative Sizes and Distances in the Solar Sytem

Some of the most important yet vexing sets of ideas to communicate in astronomy are the relative sizes and distances of objects in the Solar System and beyond. If you use say, a baseball to represent the size of the sun, the Earth would be 33 feet away in this model, and Pluto would be almost a quarter of a mile distant! No wonder students and adults alike have difficulty trying to fathom the nature of our solar system, let alone the galaxy.

One of the cleverest ideas I have seen to address at least a portion of this dilemma is what I call the "PlayDoh Universe", in which we use PlayDoh (surely one of the finest scientific lab aids ever created) to construct models for the Earth and Moon.

As your write-up suggests, it is best to work in pairs, using two small jars of Playdoh per pair.

The first part of the task is to make 51 roughly equal sized spheres. There is no need to obsessively check that all the spheres are exactly equal, but you should take some care that there are not a large number of spheres much larger or smaller than the average.

Once the 51 spheres are complete, select an average sized one and put it aside. Then, take the other 50 spheres and smush them together to make one large sphere! (Your students will love you for this...).

What is special about the relationship between these two spheres? The larger one has 50 times as much matter as the smaller, and since they are both made of the same density material, we can conclude that the larger one has 50 times the volume of the smaller one. (Remember way back when we did the "Discovering Density" experiment? Density = Mass/Volume, so if two objects have the same density (and that is the case here since both are made of the same material), we know that the larger sphere is both 50 times as massive as the smaller sphere, and has 50 times the volume.)

It turns out that by ensuring the two spheres have a volume ration of 50:1, they will fairly accurately **reflect the size ratio between the Earth and Moon!** Holding these two spheres next to each other gives a reasonably accurate image of the relative sizes of the Earth and Moon.

An exercise to do at home (Please turn this in at the beginning of Monday's Class.):

Remembering that the volume of a sphere is given by:

$$V = 4/3 \pi R^3$$

where R is the radius of the sphere, calculate or estimate the ratio of radii of these two spheres. (You can either extract cube roots, or use trial and error to estimate what number when cubed equals 50). Next, consult any standard astronomy source (there are dozens on line)[**], and find values for the radius (or diamter) of the Moon and Earth. Determine the ratio of lunar size to Earth size, and see how closely it matches your first answer. This should demonstrate why this experimental design yields two spheres that have the same relative size as the Earth and Moon.

Deciding that the larger sphere represents the Earth, we have also determined a distance scale, in which the diameter of your Playdoh Earth is equivalent to the diameter of the Earth (a distance of approximately 8000 miles or 12,800 km). A good ratio to keep in mind is that the Moon is approximately 30 Earth diameters away from us (the diameter of the Earth is 8000 miles and the average distance to the Moon is 240,000 miles). This means that if we place the Playdoh Moon at a distance equal to 30 times the diameter of the Playdoh Earth, we will have them at the proper relative distance. Measure the diameter of your Playdoh Earth, and determine how far away you would have to place the Moon to be 30 Earth diameters away. An interesting bit of classroom pedagogy would be to ask your students how far apart they think they should put the Playdoh Moon from the Earth to represent the Earth/Moon system. You could have one pair of students do this, and have the rest of the class direct them how far apart to stand. Then, you could position yourself at the proper distance (30 Earth diameters). Past experience suggests that your students will stand far too close to each other.

Once students see how far apart the Moon and Earth are, they will begin to understand better sizes and distances in the Solar System. As a wise man once said, they will have taken their first steps into a larger world.

Some questions to consider: Given the size of your Playdoh Earth, how large a sphere would we need to construct a scale model Playdoh sun? Do you think you could fit such an object in this classroom? Show how you arrive at your answers.

[**] My favorite on line site for solary system astronomy is the wonderful Nine Planets web site.