Making Scale Models

Materials:

On a central table for all to share	For each group
1. string 2. rulers or meter sticks 3. scissors (optional)	1. 1 or more cans of Play-doh. All the Play-doh for a group should be the same color. 2. large paper sheet as a work surface for rolling and shaping the Play-doh

Abstract:

Without being informed of the expected product, the students will make a Play-doh model of the Earth – Moon system scaled to size and distance. The facilitator reveals the true identity of the system *at the conclusion* of the activity. During the construction phase, students try to guess what members of the solar system their model represents. Each group receives different amounts of Play-doh, with each group assigned a Play-doh color (red, blue, yellow, white). At the end, groups set up their scale models and inspect the scale models of other groups. They report patterns of scale that they notice, i.e. as the amount of Play-doh increases, so does the size and distance of the model.

Preparation:

Color code each amount of Play-doh:

red = 2 cans, blue = 1.5 cans, yellow = 1 can, white = 1/2 can.

Divide students into small groups each containing 2 to 4 members.

Lay out materials for all groups to share in a central location.

Distribute Play-doh and one large piece of paper to each group.

Activity:

Introduce the problem

Tell the groups that they will make a scale model of two members of our solar system. Do not reveal that it is the Earth – Moon system! That's the surprise that makes this activity memorable. Along the way, they can make guesses about what the model represents.

Divide up the Play-doh into five equal size pieces

Tell groups to divide up all their Play-doh into five equal size pieces. They may use whatever creative and clever means they can think of in order to solve this problem.

Example solution: roll up the Play-doh into a long cylinder cord, then divide it up into pieces. A 50 cm cylindrical cord can be cut into 10 cm lengths, then formed into spheres.

Divide one of the five pieces into ten equally sized small pieces

Tell groups to divide up one of the larger pieces into ten equal size pieces.

Take one small piece and set it aside. Mash the four large and nine small pieces together into one big sphere

Tell each group to mash everything together (except the one small piece previously set aside) into one big sphere. Roll the remaining small piece into a little sphere.

Make a guess

After they have made two Play-doh spheres, ask each group to write down three guesses about what these solar system objects might represent. Discuss the guesses with the students. At least

one student will guess they are the Earth and the Moon. *Next, ask them to make a guess of how far apart to put their Earth and Moon spheres to make a true model.* A scientist follows up and tests guesses with observations and measurements.

Measure the big sphere diameter - this is the diameter of the Earth
Tell each group to measure the diameter of the Earth sphere. They may cut the Earth sphere in half in order to measure the diameter. They may measure with a string and mark off the diameter, or use a meter stick.

Separate the big and little spheres
After students have measured the Earth and Moon sphere diameters, ask each group to place the big and little spheres apart by 30 Earth sphere diameters. Groups with the least amount of Play-doh will probably be able to lay out their model on the table top. The two-can group might have to lay their model out on the floor.

Inspect other models, compare, and analyze
After all the groups have laid out their models, ask everyone to inspect other group's models. Discuss the results. Models will differ in three main ways, besides the color of the Play-doh: (1) the relative sizes of the Earth spheres, (2) the relative sizes of Moon spheres, and (3) the distance between the Earth and Moon spheres.
But all these differences are related to the same set of *proportions*.
The *ratios* of **Earth diameter : Moon diameter**, and **Earth diameter : separation distance** are the same for each model.

Extend
The Sun is 150 million km from Earth. Estimate how many Earth-diameters and Earth-Moon distances in your system would be needed to put the Sun in your model. Compare the sizes of the Sun and the Moon's orbit.

Background

Earth to Moon Ratio Table

	Earth	**Moon**	**Ratio** Earth:Moon
diameter (km)	12,756	3,475	3.7
volume (m^3) $V = \frac{4}{3}\pi r^3$	1.08×10^{21}	2.20×10^{19}	49

Since spherical volume is $\frac{4}{3}\pi r^3$ the ratio of Earth to moon's volume is 49.5

The mean separation between the Earth and Moon is 384,500 km. So the ratio of the Earth-Moon separation to Earth's diameter is:

$$\frac{384{,}500 \text{ km}}{12{,}756 \text{ km}} = 30 \text{ Earth diameters.}$$

In round numbers, the Earth's volume is 50 times that of the Moon, and the Moon is about 30 Earth diameters away. The Sun is 11,759 Earth diameters, or 390 Earth-Moon distances away from Earth. The diameter of the Moon's orbit is twice the Earth-moon distance = 384,500 km x 2 = 769,000 km; the diameter of the Sun is 1,392,000 km. The Moon's total orbital path around the Earth is about half the diameter of the Sun!