Live… from McDonald Observatory! Videoconference
"Discover our Solar System: Make a Size Scale Model"
Teacher Edition for grades 6-8

Introduction

The videoconference will give a brief introduction to McDonald Observatory. Students will then make a volume and distance scale model of two objects in the Solar System. The student sheets are designed to help the student discuss important concepts. Students should be directed to not fill in their sheets until prompted.

Investigation: Make a model of two members of our Solar System.

Prior to the videoconference, students should have filled in the pre-assessment sheet. The drawings and words that they use will help you gauge their pre-conceptions as well as prepare them for encountering new information about the Solar System.

The facilitator will discuss the idea of models and will lead students through a short discussion about the advantages and limitations of models. Students will then make a scale model of two members of our solar system. DO NOT reveal to them that it is the Earth and the Moon – that's the surprise that makes this activity memorable. The groups of students will have different colors and different amounts of Play-doh.


"Live… from McDonald Observatory!"
Videoconference
"Discover our Solar System: Make a Size Scale Model"
Student activity sheet
McDonald Observatory

Name: _____ Date:_____

Scale models are a way to represent something. Scale models can be used to represent the size of something, the shape, the distance, or many other possibilities. You could use a scale model to represent something that is very small (like molecules or atoms) or something that is very large (like the solar system). Today you are going to make a scale model that demonstrates the relative size (volume) and distance of two members of our solar system. You will have to guess (or estimate) which two objects you have represented.

Make 3 Guesses:

After you have made two Play-doh spheres, look closely at your model and make three guesses for what these objects might represent in the solar system.

Guess #1: _____ and _____

Guess #2: _____ and _____

Guess #3: _____ and _____

Measure the diameter of the large sphere. Within your group determine the best way to measure the diameter (there may be more than one way to do this).

For Example: Diameter = 3.8 cm

Diameter of large sphere: _____ cm

Calculate the distance for 30 "large sphere" diameters: _____ cm

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In addition to the Student Sheets, please have these materials ready in your classroom prior to the videoconference. Go through the list at least one day in advance so that you can be sure that they are available.

Materials Needed for each small group (2-4 students):
One color and different amount of Play-doh for each group: Red – 0.5 can; Blue – 1 can; Yellow – 2 cans; Green – 3 cans; White – 4 cans
Space of ~ 1 x 3 meters for groups to lay out their models
Meter Sticks (1 per group)
Thin string – 30 cm long (1 per group)
Large paper sheet – work surface (1 per group)

The facilitator will lead students in groups into dividing up their Play-doh first into 5 equal pieces, the students may use whatever creative and clever means they can think of to solve this problem. Once they have 5 equal pieces they will have to divide up one of the larger pieces into 10 equal sized pieces. They will set one of these smaller pieces aside. Then each group will mash everything together, except for the one small piece previously set aside, into one big sphere. The remaining small piece will be rolled into a little sphere.

Make Three Guesses:

Along the way students will make guesses about what the model represents. After they have made the two Play-doh spheres, the facilitator will ask each group to write down three guesses about what these objects might represent in the Solar System. Most likely at least one student will guess they are the Earth and the Moon.

Measure the Diameter of the Big Sphere:

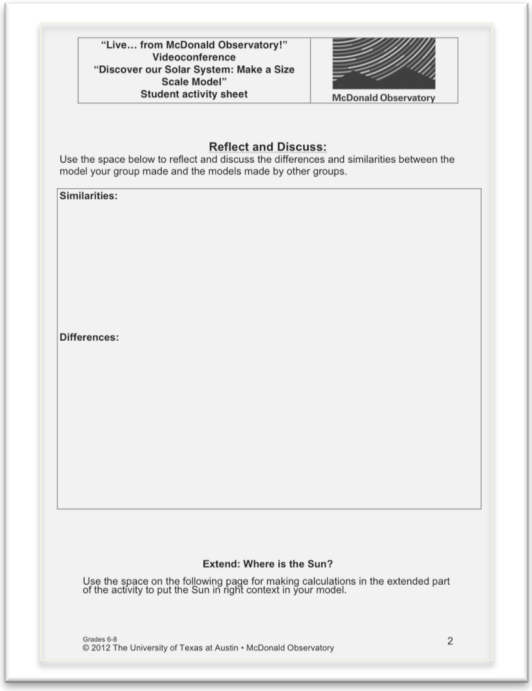
Students will measure the diameter of the big ("Earth") sphere and record their measurements (in cm) on the student worksheet. Some possible ways to do this: they may cut the sphere in half, they may measure with a string, then measure the length of the string which is the circumference, then they will have to calculate the diameter from there. Circumference = $\pi \times$ diameter. Or diameter = circumference / π.

Separate the big and little spheres:

Students will place the big and little spheres apart by 30 Earth-sphere diameters. Groups with the least Play-doh will probably be able to lay out their models on the table top. The groups with the largest amounts of Play-doh might have to lay out their models on the floor.

Inspect other models, compare, and analyze:

After all groups have laid out their models, everyone will inspect the other groups' models. The facilitator will lead the students in a group discussion. Models will differ in three main ways, besides the color of the Play-doh: the relative sizes of the Earth spheres, the relative sizes of the Moon spheres, and the distance between them. But all of 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.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Reflect and Discuss:
Use the space below to reflect and discuss the differences and similarities between the model your group made and the models made by other groups.

Similarities:

Differences:

Extend: Where is the Sun?
Use the space on the following page for making calculations in the extended part of the activity to put the Sun in right context in your model.

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Extend – Where is the Sun?:

The Sun is about 150 million km from Earth. The facilitator will lead the students through estimating how many Earth diameters and how many Earth-Moon distances in their systems would be needed to put the Sun in the model. They will compare the sizes of the Sun and the Moon's orbit.

Background: Earth to Moon Ratio

	Earth	Moon	Ratio
Diameter (km)	12,756	3,475	3.7
Volume (m^3) $V = 4/3\ \pi r^3$	1.08×10^{21}	2.2×10^{19}	49

Since spherical volume is $4/3\ \pi r^3$, the ratio of Earth-to-Moon volume is 49.5. The mean separation between Earth and the 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, 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 orbital path around the Earth is about half the diameter of the Sun. The volume of the Sun is about 130,500 times the volume of Earth, or 130,500 Earths could fit inside the Sun.

References and Extensions:

A series of NASA Moon based activities created for the NASA Lunar Prospector Mission:
http://lunar.arc.nasa.gov/education/activities/index.htm

Activities from the Lunar and Planetary Institute:
http://www.lpi.usra.edu/education/resources/s_system/moon.shtml

Other Scale Model Activities for the Solar System:
http://mcdonaldobservatory.org/teachers/classroom/SolarSystemSizeScaleModelDemo.pdf
http://www.jpl.nasa.gov/education/index.cfm?page=101