Science Unit: ***Space***

Lesson 8: ***Moon Regolith***

Summary	Students learn about the phases of the **Moon** and relate its appearance to its mountains and larval plains. They also experiment with rocks to understand how **Moon regolith** forms and explore its **electrostatic properties**.
School Year:	2014/2015
Developed for:	Lord Strathcona Elementary School, Vancouver School District
Developed by:	Ingrid Sulston (scientist); Reid McInnes and Phyllis Daly (teachers)
Grade level:	Presented to grade 6/7; appropriate for grades 1 – 7 with age appropriate modifications
Duration of lesson:	1 hour and 20 minutes
Notes:	This lesson included two activities, the first of which is written up as "Phases of the Moon" in Lesson 7 of the Space Unit, Scientist in Residence Program:

Objectives

1. Manipulate the relative positions of a model Moon and sun, to understand why the Moon is different shapes (phases) at different times during the month.
2. Relate the appearance of the Moon to its mountains and larval plains.
3. Experiment with rocks to understand how Moon regolith forms and explore one of its properties.

Background Information

The Moon is a familiar object to most older students, and they have likely noticed how it changes shape through the month, and the light and dark patterns on it. Through personal experimentation with a Moon phases model, it is hoped that when students look up at the Moon again, they will more deeply understand that what we see is the Sun's reflected light and why the shape of the Moon changes with its position. This new way of looking at the Moon may even initiate an understanding of how far away from Earth the Moon really is, and a renewed admiration for those that have travelled there.

Students are likely to know about the historical Moon landings. A practical implication of landing on the Moon is the fine Moon dust which sticks to everything. Through direct interaction with rock dust and its electrostatic properties, students will start to grasp the complications of instrument maintenance while on the Moon, as well as the reason for dirty-looking spacesuits.

Vocabulary

Moon	The natural satellite of earth. The Moon shines by reflecting sunlight back to earth and can be seen during both day and night. The Moon orbits earth in a month.
phase of the Moon	The shape of the sunlit portion of the Moon, which changes through a month.
regolith	A layer of loose material covering solid rock, made up of dust and soil. Regolith is found on Earth, the Moon, Mars, some asteroids, and other planets and moons.
electrostatic material	A material that can gain or lose charged electrons, when it is rubbed against another material. Electrostatic materials tend to cling to each other as their charges attract each other.

Materials (for groups of two or three students)

- rocks that create dust when banged together
- shallow cardboard box or tray with a white paper lining
- clear plexi sheet that covers the box
- goggles, or a screen, to stop flying rock pieces from getting in eyes

In the Classroom

Introductory Discussions

1. Ask students if they have looked at the Moon, and what shapes they have seen. Refer to an image of the 's phases with discussion (Ref. 1).
2. Tell students that they will be modeling how the Moon moves through its different phases.
3. Option to do Activity (1).
4. Show students a high-resolution image of the Moon (Ref. 2). Ask if they see any images in there, or have heard of stories that relate to images in the Moon. During discussion, show students some of the images that different cultures see (e.g. a man or a rabbit). (Ref. 3)
5. Galileo was the first to realise that the Moon was mountainous, not smooth as most people thought. Now we know that the Moon has mountains and craters, as well as dark lava plains. The Moon does not have tectonic plates to uplift mountains - its mountains are formed by the impacts of other bodies colliding with the Moon.
6. These impacts also form the "regolith" which covers the surface of the Moon, a fine dust a whose depth varies from a few metres to tens of metres.
7. Tell students that they will model the formation of Moon regolith, then look at one of its properties that has made work on the Moon challenging.

Processes of science that the students will focus on: mechanical manipulation, close observation, inferring, concluding.

Safety guidelines: students will be banging rocks together in the activity (2), so will need to wear safety goggles to avoid eye damage.

Science Activities

(1) Activity: Phases of the Moon

Purpose of Activity: To model how and why the Moon's shape appears to change during the month.

Methods and Instructions:
See: Activity (1), "Phases of the Moon" in the lesson posted at
www.scientistinresidence.ca/pdf/space-science/Space/SRP_Space_Lesson_7.pdf

(2) Activity: Moon Regolith

Purpose of Activity:

To make rock dust in the same way that Moon regolith is formed, then explore its electrostatic nature.

Methods and Instructions:

Set-up prior to experiment: none

Students will work in groups of two.

1. Tell students that they will simulate the formation of Moon regolith (Moon dust), by banging one rock (the surface of the Moon) with another rock (a meteorite). Remind students that all Moon regolith is formed by impact - there is no wind or water to erode rocks to dust. Ask students to bang their rocks over the tray with the white lining, and to collect the dust in the tray.
2. Once students have collected a pile of regolith in their tray, inform them that they will look at a property of the regolith. Instruct them to lay the Plexi sheet over the tray of regolith, and rub a hand over it.
3. Ask students to complete their worksheet (attached, following this lesson).
4. Students should find that the regolith jumps up to the plastic, and dances up and down, and they can spend a while experimenting with it. If they cannot get the dust to jump, tell them to try using a drier (non-sweaty) hand and rubbing faster (rubbing a piece of cloth on the Plexi may also help).
5. Explain that the regolith jumps because of electrostatic charges. Rubbing the Plexi sheet gives it a charge, which attracts the tiny grains of regolith that are also charged.
6. Compare to Moon regolith: Moon regolith is even finer than the dust made in the classroom (some is 1/100 mm wide). It is also more charged (because it is bombarded by charged particles from space). These factors make it even more electrostatic than the dust the students made. When humans land on the Moon, the dust coats space suits, solar panels and camera lenses. Show students an image of a dirty spacesuit (Ref. 4).
7. Inform students that Moon regolith is also sharp enough to wear away space suits and scratch visors. Show them an image of Moon regolith magnified (Ref. 5), and discuss how it is different form the sand grains on earth (which is much more rounded from erosion by wind and water).
8. Technology has overcome some of these challenges of Moon regolith, for example electric fields are wired on camera lenses and surfaces to attract the Moon dust to the side of the lenses.

References

1. <http://spaceplace.nasa.gov/oreo-Moon/en/Moon_phases_all_L.jpg> Image of the phases of the Moon. NASA. Accessed May 12, 2015
2. <http://www.nasa.gov/centers/langley/images/content/528691main_Super_Moon.jpg> Image of the full Moon. NASA. Accessed May 12, 2015
3. <http://en.wikipedia.org/wiki/Man_in_the_Moon#mediaviewer/File:Man_In_The_Moon2.png> Drawings overlaying the full Moon, depicting what different cultures see. Wikipedia. Accessed May 12, 2015
4. <http://upload.wikimedia.org/wikipedia/commons/b/b1/Schmitt_Covered_with_Lunar_Dirt_-_GPN-2000-001124.jpg> Image of a regolith-covered space suit. Wikipedia. Accessed May 12, 2015
5. <http://science.nasa.gov/media/medialibrary/2006/12/28/28dec_truefake_resources/variety_big.jpg> Image of Moon regolith magnified. NASA. Accessed May 12, 2015