Science Unit: *Space*
Lesson 7: *The Moon and Stars*

School Year:	2012/2013
Developed for:	Sir Wilfrid Laurier Elementary School, Vancouver School District
Developed by:	Ingrid Sulston (scientist); Patricia Ellis and Barbara Duncan (teachers)
Grade level:	Presented to grades 1-3; first activity appropriate for grades 1-7 with age appropriate modifications; second activity appropriate for grades 2-7.
Duration of lesson:	1 hour and 30 minutes

Objectives

1. Learn why the moon is different shapes (phases) at different times during the month, and the role of the sun in forming these phases.
2. Understand the mechanics of lunar and solar eclipses.
3. Gain new perspective on how the stars in familiar constellations are separated in space.

Background Information

The moon and stars might be familiar objects to some students, but other city-dwelling children, especially in cloudy Vancouver, have very infrequent views of clear night skies, or of an unobstructed skyline for viewing the moon in the daytime. Hence they might not think much about the moon and stars and our relationship to them.

Once discussions start on the moon and stars, students are generally very interested in knowing more about our relationship to them, and are interested in trying to grasp our place in the hugeness of space. However, the long lengths of time over which things change, and the huge distances involved, make these topics challenging to cover in a meaningful way in the classroom. Modeling our relationships with the sun, moon and stars may not be direct experience with these objects, but can overcome these challenges.

This lesson uses models to address two relatively familiar astronomical phenomena: the phases of the moon and the shapes of star constellations. Both models can be manipulated to change the view seen from earth, so that students have some moving mechanics to visualize when they do encounter the real phenomena.

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.
Eclipse:	When an astronomical object is obscured by another object or its shadow.
Star:	An enormous ball of plasma (a heated gas) that emits light and other energy.
Sun:	The nearest star to earth, around which the earth orbits (along with other planets).
Constellation:	A group of stars perceived as forming a figure or design. e.g. Orion.
Asterism:	The most recognizable part of a constellation e.g. the Big Dipper is the asterism in the constellation Ursa Major.
Galaxy:	A group of trillions of stars. Our star (the sun) is part of the Milky Way galaxy.

Materials

- Darkened area that can fit the whole class e.g. classroom with black out curtains/ space behind stage curtains.
- Light fixture with a bare bulb, elevated on a chair or other raised surface: “the sun”.
- White styrofoam balls, one for each student, 7cm diameter or more: “the moon”.
- Chopstick, or other sturdy stick, one for each student, pushed into their styrofoam ball to make a handle.
- images of phases of the moon (e.g. from Google images)
- Images of the constellation Orion and of the Big Dipper: photo of the real stars and/or drawings of the figures people have superimposed on the star patterns.
- Tin foil to make balls: “stars”. Seven sheets of about 15cm x 15cm for each group of students.
- Thin black thread. Seven lengths of about 35cm for each group of students.
- Masking tape, about 16 short (~3cm) lengths for each group of students.
- Stiff cardboard, cut into a circle about 60cm in diameter, and covered in black paper on one side. One for each group of students. (It needs to remain flat when hung from the edges - reinforce if necessary.)
- Skewers to poke holes in the thick cardboard.
- String to hang the models up.
- Table of thread lengths for each group’s constellation (see worksheet 3 at the end of the lesson).
- Constellation templates, one for each group, either the Big Dipper or Orion. We used adapted templates from ref. 4 - see worksheets 1 and 2 at the end of this lesson.

  [One star (Alcor) was removed from the Big Dipper template in ref. 4 to avoid a double star; one star (Meissa) and the Orion Nebula were removed from the Orion template in ref. 4, so that all groups of students had seven stars.]

In the Classroom

Brief description of science activities:

- The Moon Phases activity models the changing phases of the moon, as viewed from earth.
- The Constellation activity models the spacing of stars in a constellation and its unique view from earth.

Brief description of the processes of science that the students will focus on: observation, reading a table, measuring, mechanical manipulation, inferring.

Introductory Discussion for Phases of the Moon activity

Show a photo of the moon over our city. Ask students if it always looks like this. Have they noticed when it is visible? (It can be visible either by night or day.) Have they noticed its shape change?

Show them an image collection of all the phases of the moon, to show how the moon changes shape through a specific sequence through a month. The moon orbits the earth, and depending on where it is in its orbit, it will look like one of the images.

Ask students if they know why parts of the moon are bright. (It is the light from the sun reflecting off the moon.)

Science Activity

(1) Activity Title: Phases of the Moon

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

This activity is found in many hands-on space-science collections, including refs. 1 and 2.

Methods and Instructions:
Set-up prior to experiment: set up in a room or space that can be darkened. Place the light fixture and bulb on the chair in the centre of the space.
Students will work in one large group, circled around the light bulb.

1. Hand out a "moon" to each student, and ask them to stand in a large circle around the bulb, with two arm length's space between each student if possible. Tell them that their head is the "earth", and they will be viewing their moon from earth.
2. Ask the students how the moon moves around the earth - they can mimic the movement by moving their model moon around them, turning their body with it so they can see the moon at all times. The real moon rotates around the earth once each month.
3. Darken the room so that the only light source is the bare light bulb in the centre of the room - the "sun".
4. Ask students to turn their backs to the sun and hold their moon at arms length away from them. The moon should appear fully lit as the sun's light reflects from it. (Make sure the earth (their head) does not make a shadow on the moon.) Take a moment to make sure that all the students understand that their moon looks bright because of the sun's light reflecting from it and back to their eyes. When the real moon is in this position, on the far side of the earth from the sun, we see a bright circle of reflected sunlight, which we call a "full moon".
5. Now ask students to turn around and face the sun and hold their moons in front of them at arms length, towards the sun but not covering its light. They should see the sun, and the dark side of their moon. When the real moon is positioned between the earth and the sun, the side facing us in in shadow and is not visible - called a "new moon".
6. From this position facing the sun, ask the students to slowly move their moon to their left. As they do so, they should see a bright crescent appearing on the side of their moon as they start to see the sun's light reflected from part of it. The real moon in this position relative to the earth and sun forms the same bright curve, and is called a "crescent moon".
7. As students continue to move their moon around them to the left (turning their body with it), the crescent will become wider half of their moon is illuminated - called a "half moon".
8. Continuing to turn, they pass through the full moon that they have viewed already, another half moon, another crescent moon (curved in the other direction this time) and finally the new moon again.
9. The entire rotation of the real moon around the earth takes a month, and during that month we see the moon pass through these same phases.
10. The students should be given time to experiment with their model, so that they can fully understand how the sun's reflected light makes the shape of each phase.
11. If students come across the following phenomena, and/or if they are ready more more information, eclipses can also be modeled:

    A lunar eclipse occurs when the earth's shadow falls on the moon, and can only occur at full moon (ref. 3, p.93). To model this, students face away from the sun and use their head to block the sun's light from falling on the moon.

    A solar eclipse occurs when the moon passes directly in front of the sun, blocking its light from reaching earth (ref. 3, p. 160). To model this, students face the sun and use the moon to partially or totally block the sun's light reaching earth.

Introductory Discussion for Constellation activity

Show images of the constellation Orion and the Big Dipper. (The Big Dipper is actually an “asterism”, part of the Ursa Major constellation.) Ask students if they are familiar with either of them. Discuss how people on earth have seen these same patterns of stars for a long time and have given them names.

Tell students that these star patterns only look like this from our place in the galaxy. Students will make a model of these constellations to find out how the stars are actually spaced and to find what pattern they make when viewed from other places in the galaxy.

Science Activity

(2) Activity Title: Constellation model

Purpose of Activity: To show how the stars in familiar constellations are placed in space, and what pattern they form from other places in the galaxy.

Adapted from ref. 4. A variation on this activity is in ref. 5.

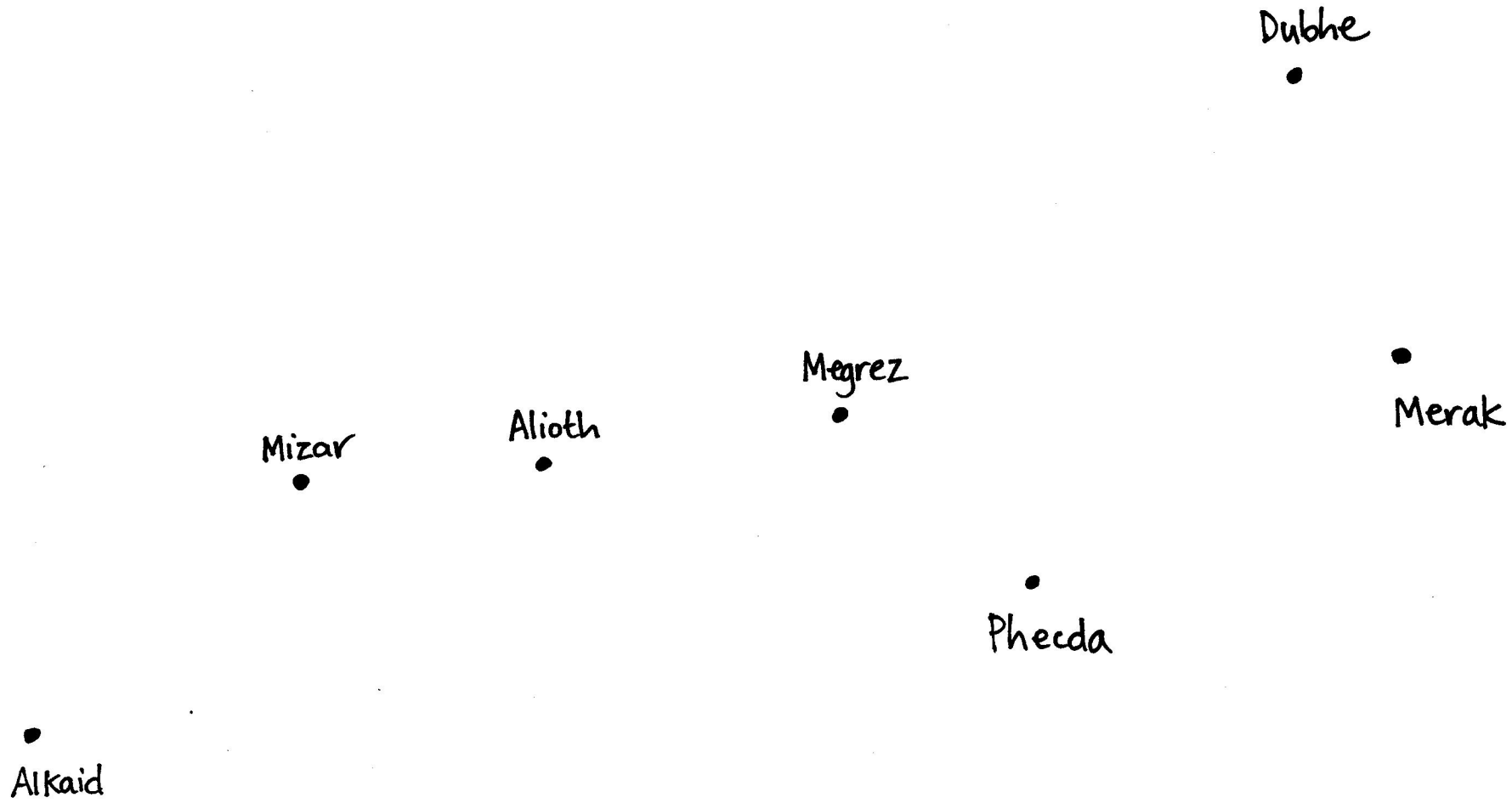
Methods and Instructions:
Students work in groups of three or four to build a constellation.

1. In their groups, students first make the stars for their constellation. First use masking tape to secure one end of a black thread to the centre of a piece of tin foil. Then crumple the foil into a ball around the end of the thread, to make a silver ball hanging on the end of a long thread. Repeat for the remaining six stars. Keep the hanging stars separate so that their threads do not tangle together.
2. Prepare the black cardboard circle for hanging the stars: lay a constellation template on the centre of the black side of the cardboard circle. Tape it lightly in place, so that it does not move, but the tape can be removed again. Use a skewer to poke holes through the cardboard corresponding with the pattern of stars. Remove the constellation template.
3. Choose which star to hang first, then check it’s position on the cardboard by looking at the constellation template, and check its thread length on the table of thread lengths. Push the free end of the thread (the other end from the star) through the correct hole in the cardboard, using the skewer to push it through. Pull the thread through the hole until the star is hanging the correct length below the black side of the cardboard, then tape the excess thread on the backside (non-black) of the cardboard to secure it. Lastly, lightly tape the hanging thread and star to the black cardboard so that it does not get tangled with other stars as they are hung, but so that the tape can be removed once all the stars are hung. Repeat threading, measuring and hanging for each of the stars.
4. Once all the stars are threaded through the cardboard, remove the temporary tape to release them into hanging position, then hang the model from the ceiling or a wire with string.
5. Stand or lie directly under the constellation. It should look as we see it from earth. The black thread should be invisible against the black cardboard, and the shiny stars appear to float.
6. Move to the side slightly and notice how the stars that appeared to be in the same plane are in fact at very different distances from “earth”. As you move around, you are seeing the constellation from different places in the galaxy.

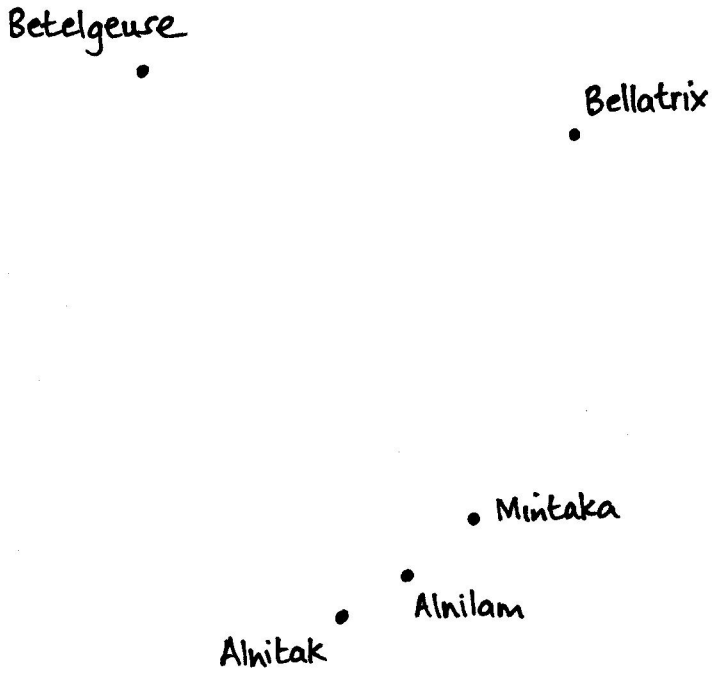
References

1. <http://www.nasa.gov/centers/jpl/education/moonphases-20100913.html> NASA Jet Propulsion Laboratory Education webpage. [One source for the Moon Phases activity.] Accessed May 24, 2013.
2. Kiely, Rob. 2009. Science Experiments (Pocket Pal series). Pp. 86-89. Hinkler Books. [Another source for the Moon Phases activity.]
3. Couper, Heather and Henbest, Nigel.1999. Encyclopedia of Space. DK.
4. <http://www.astrosociety.org/edu/activities/F7_3D_Constellations.pdf> Astronomical Society of the Pacific Education Programs. [Constellation activity adapted from this source.]
5. Wiese, Jim. 1997. Cosmic Science. Wiley. An excellent source of space science hands-on activities, including a variation on the constellation activity.

Big Dipper



Orion


Betelgeuse
Bellatrix
Mintaka
Alnilam
Alnitak
Rigel
Saiph

Big Dipper stars

Star	Alkaid	Mizar	Alioth	Megrez	Phecda	Merak	Dubhe
Thread length (cm)	15	26	24	24	23	26	3

Orion stars

Star	Betelgeuse	Bellatrix	Alnitak	Alnilam	Mintaka	Saiph	Rigel
Thread length (cm)	21	30	17	3	14	19	17