APPENDIX B

VIEWING THE MOON IN THE SOUTHERN AND NORTHERN HEMISPHERES

In the preceding section we indicated that the Moon appears differently to viewers in the Southern and Northern Hemispheres. For example, the waxing crescent might appear at dusk on the lower right side to the viewer in, say, Chicago, Illinois, but the same Moon will tend to appear on the lower left when viewed at dusk on the same day in Sydney, Australia.

How can we help students understand how that happens? After all, both viewers are looking at the same Moon, so how can its shape be different for the two viewers.

Australian Waxing Crescent Moon

Waxing Crescent MOON in Chicago

Waxing Crescent Moon Viewed by Australian Students and Students in the Continental U.S.

Start by pairing your students. One student per pair should draw a heavy arrow on a piece of paper. The arrow needs to be heavy enough so that it can be seen from both sides of the paper. As the students face each other one meter apart, one student should hold the paper between them so that both students can see the arrow.

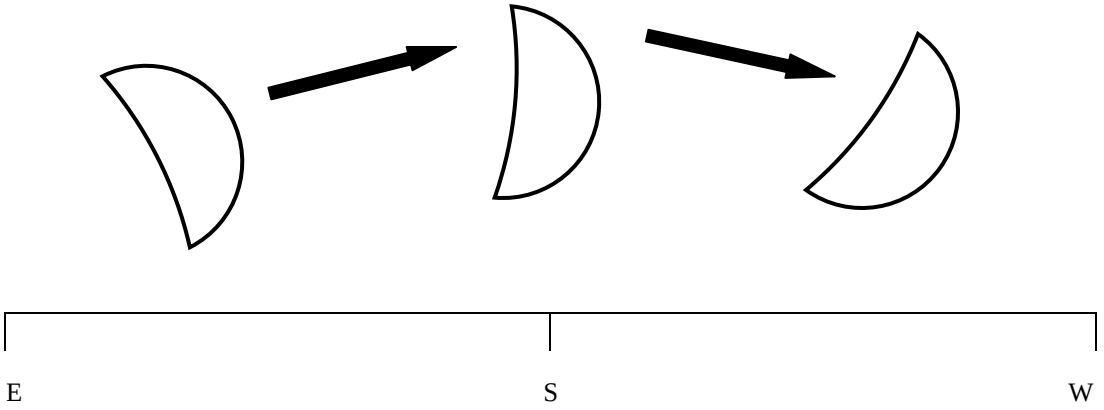
Ask them which direction – right or left – the arrow is pointing. For one student, the arrow will be pointing to the right. For the other, the arrow will be pointing left. It's the same arrow, but to the two viewers, it appears to be pointing in opposite directions. Ask why it appears to be pointing in opposite directions. The students should figure out that the direction the arrow points is dependent on both the arrow – the object being viewed – and the perspective of the viewers. In this case, the viewers are facing each other, so there is a 180^{o} difference in their perspective relative to the arrow.

Next, while the students continue to face to other, have one of the students hold the paper above his/her head so that the arrow is pointing to the student's right and so both students can see the arrow, as if they both were looking skyward. Again ask them which direction – right or left – the paper is pointing. For one, the arrow is pointing to the right; but for the other, the arrow is pointing left. Why might that be? Again, students should recognize the importance of each viewer's perspective.

Ask the students to hold on to that idea while doing the next activity.[1]

Before doing this next activity, Northern Hemisphere students should have viewed the Moon for several hours and observed that the waxing crescent tends to appear on the right side, and also figured out that it moves across the sky from East to West (in the Northern Hemisphere) from hour to hour, just as the Sun moves from East to West from hour to hour as the day goes by. They also should have discussed with Southern Hemisphere students the Moon's appearance and should have found out from their Southern Hemisphere partners that the waxing crescent in the Southern Hemisphere tends to appears on the left side; and the Moon moves from hour to hour from East to West in the Southern Hemisphere. Finally, they should have figured out that in the hour to hour timeframe the Northern Hemisphere viewer will see the Moon moving from left to right (i.e., from East to West). But the Southern Hemisphere viewer in the same timeframe will see the Moon move from their right to left (i.e., from East to West). How can it be moving from right to left in the Southern Hemisphere but from left to right to the Northern Hemisphere viewer?

Again pair students. One of the students should draw three half moons on a blank sheet of white paper, as shown in this drawing. Below the Moons they should draw a horizontal line with marks to show where East, South and West are. Finally, they should draw arrows to show how the Moon moves from East to West in an hour to hour time frame. When they are making these observations, the two students should stand shoulder to shoulder with the paper on the desk in front of them so that they are looking at the Moon from the same perspective.



Next students should face each other while one of them holds the drawing between them so that one student is viewing the Moon as drawn and the other student is viewing the paper from behind. The first student viewing the front side of the piece of paper is observing the Moon as seen from the Northern Hemisphere, but the second student, looking at the paper from behind, is viewing the Moon as seen from the Southern Hemisphere. (The second student is looking North; so in her or his mind, she or he needs to change the S [South] to N [North]. Otherwise the drawing and directions are correct for both viewers.

Which way is the Moon moving across the sky for both students? Both see the Moon moving from East to West; but that's left to right for the Northern Hemisphere viewer and right to left for the Southern Hemisphere viewer.

[1] Based on Ginns, I. S. (1993). Extension activities in astronomy for primary school children. *The Queensland Science Teacher, 19*(3), 32-34.

Which side of this waxing crescent half moon is illuminated? The Northern Hemisphere student will see the right half illuminated but the Southern Hemisphere students will see the left half illuminated.

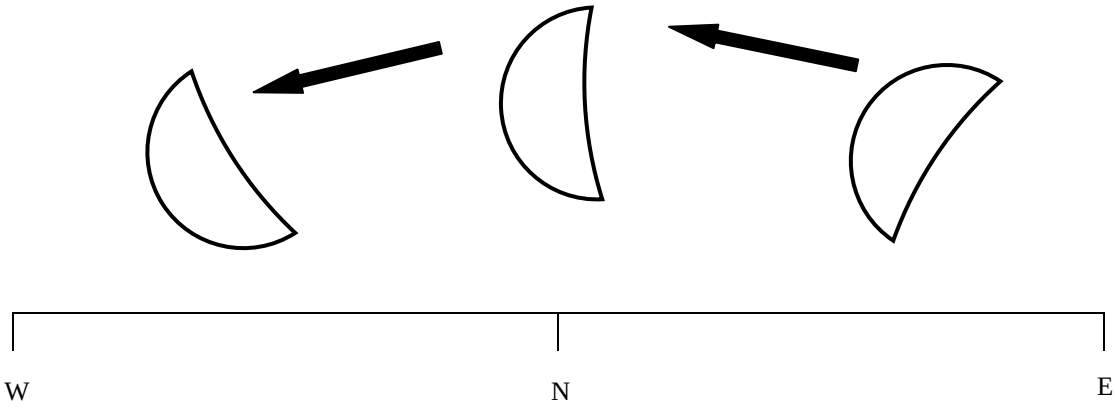
Are the two students seeing two different parts of the Moon? No. They are seeing exactly the same part of the Moon; but because of the two viewers' differing perspectives, one sees the illuminated part to the right and the other sees it to the left.

Finally, as the students continue to face each other, have the students hold the paper above their heads and between them so that both can see the front of the paper. The paper should be oriented so that East is to the left of the "Northern Hemisphere" student and to the right of the "Southern Hemisphere" student. Again, the drawing and labeling are correct for both students except that the "Southern Hemisphere" student is looking north, whereas the "Northern Hemisphere" student is looking south (as the drawing is labeled. Also, the drawing of the Moon from the "Southern Hemisphere" student's perspective will seem to rise high, dip down, and then set high, so the "Southern Hemisphere" student will have to mentally realize that the Moon rises at the eastern horizon, moves to the top of its arc across the sky, and sets at the western horizon.

Which way is the Moon moving from hour to hour? Both will say the Moon is moving from East to West; but from the "Northern Hemisphere" student, this is left to right whereas for the "Southern Hemisphere" student, this is right to left.

Which side of the Moon is illuminated? The "Northern Hemisphere" student will see the illuminated part on her or his right; but the "Southern Hemisphere" student will see the illuminated on his or her left.

Southern hemisphere teachers should modify this activity by having their students draw the Moon as their students have been viewing the Moon (as shown in this drawing).

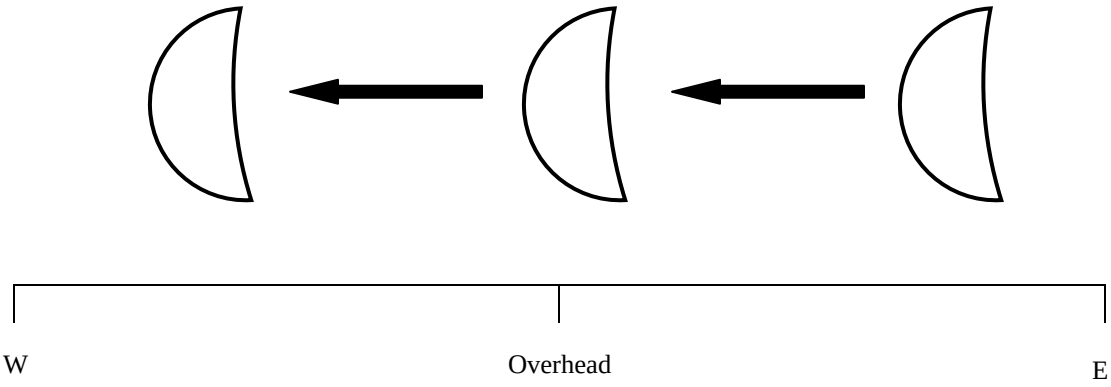


Having had your Southern Hemisphere students draw the Moon and label directions in this way, you can have students make the same observations as made by Northern Hemisphere students and you can ask the same questions.

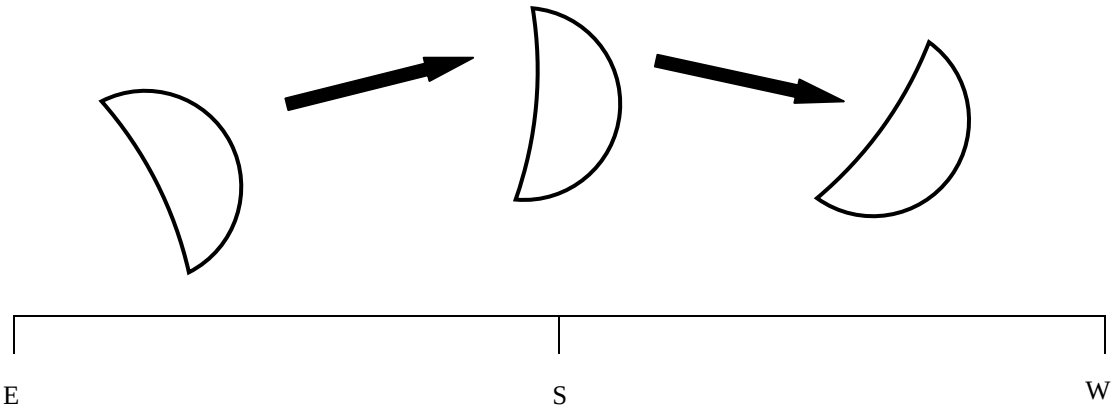
If you and your students really "get into" this topic, you might be interested that . . .

When writing these directions I have been envisioning teachers and students living at about 30-40^{o} north or south of the Equator. The closer you get to the Equator, the more the Moon may be directly overhead at certain times.

If your school is located in, say, Brisbane at about 27º South, at some times the Moon passes nearly directly overhead. Thus, instead of seeing the Moon in the Northern sky, as shown in the drawing above, the Moon will move across the sky more like this drawing.



This time when the students hold the paper over their heads, the "Southern Hemisphere" student (who is standing in Brisbane when the Moon is passing more or less overhead) should hold the paper directly over his or her head. The "Northern Hemisphere" student should stand a meter away. For this student, standing in, say, Chicago, Illinois, the Moon they see will look more like this drawing.



Both students will see the Moon moving from East to West. The "Northern Hemisphere" student will see the right side of the Moon illuminated. The "Southern Hemisphere" (Brisbane) student will see the lighted surface of the Moon on the left side and more or less on the top of the moon when first viewed looking toward the East and more or less on the bottom of the moon when seen as it sets in the West. (Of course, when the Moon is "on top" in Brisbane, the Sun will also be out and bright, so observers will have to look hard for the Moon at this time.)

The great big message to learn from all of this goes back to the arrow exercise. What you see depends on what is happening AND on the perspective of the viewer.

In this particular case, the Moon is doing whatever the Moon is doing. Any differences in what we see is due to the differing perspectives (or frames of reference) of the viewer in different parts of the world.