Teacher’s Notes for Moon Phase Observing Activity

Students will make observations of the positions and phases of the moon over the course of two weeks. The most important thing will be for them to observe the moon at the same time each night. (Within a half hour of the same time is acceptable.) I recommend that they make their observations in the early evening. (Contact me for suggestions if someone wants to observe at a different time.) Assuming that they will be observing the moon in the early evening, they should start their observations two days after a new moon.

You can find the phases of the moon by going to

http://aa.usno.navy.mil/data/docs/MoonPhase.php

and clicking on ‘get data’.

Emphasize a number of times during the two weeks of observations that they should be observing the moon at approximately the same time every night; otherwise they won’t get good results.

One lesson here is for the students to, as scientists do, report observations accurately and honestly. For instance, on the first day of observations, the moon may be hidden by nearby houses or trees, and they won’t be able to see it. Then they should record something like “moon not visible.” On any night that is too cloudy (or rainy or snowy) to see the moon, they should record “cloudy” (or “raining” or “snowing” as appropriate). It’s all right if there are many nights when they can’t see the moon (or are occasionally unable to observe due to other obligations). They won’t need observations every single evening to see the pattern (although you might not want to mention this at the beginning). It’s best if they attempt an observation every evening.

To record the position of the moon in the sky, students will be estimating the *altitude* and *azimuth* of the moon. Altitude is the number of degrees above the horizon. The highest the altitude can be is 90 degrees, which would be at the zenith. (Teach the word *zenith*? It’s the point directly overhead.) Halfway up would be 45 degrees. You can estimate altitudes by using the fact that your fist held at arm's length makes an angle of approximately 10 degrees. (Check this by seeing if it takes about 9 fists to go from the horizon to the zenith -- See picture.) Students can test this out in class.

© 2012 Dr. M. Bobrowsky — matt@msb-science.com

To measure azimuth, students will first have to know which way is north. There are a number of ways to determine this. One way would be using a magnetic compass. Another way is to see where the sun rises (near the east) or sets (near the west). Or use the fact that at noon the sun is in the south; so shadows will point north at that time. (It can be a weekend assignment for students to go out one day at noon and see which way their shadows point. Then they'll know which way is north.)

Azimuth is the number of degrees around the horizon measured from north, toward east. If an object is due north, its azimuth is zero. You can again use your fist to measure (in 10º increments) the number of degrees around from north — holding your fist sideways. Except that you don't always need to start from north if you remember that due east has an azimuth of 90º, due south has an azimuth of 180º, and due west has an azimuth of 270º. So, for instance, if the moon is one fist to the right of due south, its azimuth must be 180º + 10º = 190º.

After they've made the first week's observations, they should look at the pattern on their graphs and write a hypothesis — a possible explanation for why the moon appears to be doing what it's doing. This should be based only on their observations so far, and not on any other information such as Web research. They should turn in a *copy* of pages 3 and 4 at that point. (Maybe give them two copies of those pages to begin with and ask them to record on both copies.) So after the first week, they should turn in one copy and keep a copy for themselves so they can continue recording their observations for another week. Then they should turn in the completed activity (with all the pages) at the end of the two weeks of observations. Do not deduct points for an incorrect hypothesis after the first week's observations. It's not bad to have a wrong hypothesis (at first).

Optional part: Time at Meridian (This involves that fact that the moon appears to move from east to west each day, just as the sun does, due to the earth's rotation.)
You can decide not to have the students do this part or use it for "extra credit" or whatever. The activity asks for an estimate of the time when the moon was (or will be) at the meridian. The *meridian* is an imaginary circle that runs from north to south through the zenith. When the moon crosses the meridian, at an azimuth of 180º, it's highest in the sky. (This involves that fact that the moon appears to move from east to west each day,

just as the sun does — due to the earth's rotation.) So, looking at where the moon is now, to estimate the time when the moon was (or will be) at the meridian, note the azimuth of the moon now and subtract 180º to get the number of degrees that the moon is from the meridian. Then use the fact that the earth rotates 15º per hour. For instance, if the azimuth of the moon is 210º, you'd have 210º - 180º = 30º, so the moon must have been at the meridian 30º/(15º/hour) = 2 hours earlier.

If the moon's azimuth is less than 180º, then it hasn't reached the meridian yet. For instance, if the moon's azimuth is now 165º (which would be in the southeast, right?), then, since 180º-165º = 15º, the moon will reach the meridian one hour from now.

An aside: When the moon crosses the meridian, having an azimuth of 180º, it's highest in the sky. That's true for the sun as well. The sun crosses the meridian at "apparent noon" which occurs closer to 1:00 p.m. when we're on daylight saving time.

You can have them complete the questions on the last page as a group activity in class, or as homework.

Grading:

- Check to see if students made their observations at about the same time each night.
- Over the course of the two weeks, did they note the changing phase of the moon?
- Over the course of the two weeks, did they observe the altitude of the moon to rise and fall, being highest when its azimuth was approximately 180º?
- Did the azimuth consistently decrease over the two weeks?
- We're not so concerned with the hypothesis they made after the first week's observations. But their revision to it (if any), as described in Question 1 on the last page, should make sense in light of their observations. Consistency with their observations is far more important than simply having a correct answer.
- Some answers to the questions on the last page of the activity (and a comment or two on a few of the questions) are provided below.

© 2012 Dr. M. Bobrowsky — matt@msb-science.com

Part 2: Test your hypothesis

Continue to observe the moon at the same time as you did previously each clear night for the next week. (If you run out of room on your data sheet, continue the data sheet on another sheet of paper.) Continue to tabulate and graph your results as before. (Keep adding to your original graph.) At the end of the week, answer the following questions.

1. Were your observations during the second week consistent with your original hypothesis? Did you need to revise your hypothesis in light of the additional observations? If so, explain.

   [It's fine if the original hypothesis was correct — that the changing phases and position of the moon in the sky result from the orbital motion of the moon around the earth — but it's great if the original hypothesis was wrong and then, after the second week's observations, the student modifies and corrects the hypothesis. That student understands the nature of science.]

2. As the shape of the moon's illuminated surface changes, how does its location in the sky change from night to night at the same time?

As the moon becomes more and more full, it first gets higher and higher in the sky each night, but then starts to get lower again in the following days. The moon's azimuth continually decreases.

3. Make an estimate of the number of degrees the moon shifts each day due to the moon's revolution around the earth. Use the azimuth values from two of your observations spaced at least several days apart. Show your work.

   _____________ degrees per day Example calculation: Say that on one day the azimuth was 210º and three days later the azimuth was 250º. Then the amount the moon moved each day was $(250^{o} – 210^{o}) / 3$ days $= 40^{o} / 3$ days $= 13$ degrees/day.

[Note that this is close to the value you'd get if you use the fact that the moon appears to make one complete orbit (360º) in 29.5 days:
$360^{o} / 29.5$ days $= 12^{o}$ / day.]

4. Moonrise is (later, earlier) each night as the moon goes through its phases.
   Later

5. At what phase is the moon closest to the sun in the sky?
   New moon

6. At what phase is the moon farthest from the sun in the sky?
   Full moon

7. Do you feel that you made enough observations to understand the phases and motion of the moon?
[Their answers to this should be consistent with what they wrote for Question 1.]

© 2012 Dr. M. Bobrowsky — matt@msb-science.com