

Motion of the Moon

Objectives: You will see how the position of the Moon in the sky changes from night to night. You will also get some experience with using numerical measurements to describe what you see.

Summary: You will look for the Moon on at least 20 nights, always at the **same clock time** and from the same city. Whenever you see the Moon, you will measure its azimuth (angle from the North) and elevation (angle above the horizon) and make a note of its phase. Your results will be turned in online as a spreadsheet file.

Materials: You will need the following materials:

Two pieces of 8.5x11 inch card stock or photo paper. (Should be available at the VCU Bookstore. Check out art stores for individual sheets.)

A foot or so of string or thread.

An object to tie on the end of the string as a weight.

Scissors

An internet-connected computer with a printer.

The Compass Card: Print out the file `compass.pdf` (from the projects link on the open course website). It is best to print it on a sheet of card stock or photo paper. Plain paper will also work, but is less satisfactory because it tends to blow around when there is wind.

Constructing a Quadrant: Print out the file `quadrant.pdf` (from the projects link on the open course website). Here you really need to use card stock or photo paper. Cut around the solid line edge of the picture and make a short slit in the indicated place to hold the string. Fold the edges as indicated. Tie a knot in one end of a piece of string and something (a paper clip, a bead, or whatever) to the other end. Pull the string through the slit and you have your quadrant. Although plain paper will not work for the final device, it is a good idea to start by making one out of plain paper so that you can make your mistakes without spoiling your card stock or photo paper (which is expensive).

Placing the Compass Card: Place the compass card on the ground, with the directions lined up properly. One good way to do that is to use a mapping website such as `mapquest.com` to obtain a map of the streets near your observation point. Enlarge the map so that it shows only the nearby streets and notice which way north is on the map (usually toward the top). Print out the map and bring it with you to your observation point. Lay the map down on the ground so that the images of local streets are parallel to the real streets. Then lay the compass card down on top of the map with north pointing the way it does on the map. Use some stones to hold the compass card in place. If you observe from the plaza at the entrance to Cabell Library, you can just line up the compass card with the compass rose painted on the plaza.

Making an Observation: Hold the quadrant so that it is in a vertical plane (indicated by the weighted string just barely touching it). Aim the folded edge marked 'To Moon' at the Moon and sight along it. If the Moon is high overhead, you may need to change the direction you are facing in order to get everything lined up and you may also need to hold the quadrant well away from your face so that the string can swing free. Now pinch the string against the quadrant so that you can read where it is on the scale without having it move. Note which way you are facing and compare that to the compass card. The angle that is closest to the direction you are facing is the *azimuth* of the Moon. The angle that the string is pinched against on the quadrant is the Moon's *elevation*. Record the azimuth, elevation and the exact time and date of your observation.

Consistency Checks: It is easy to get things turned backwards. Just to make sure you are doing things correctly, aim the quadrant at the horizon and measure its elevation. You should get close to zero. Aim the quadrant at a point directly overhead and measure its elevation. You should get close to ninety degrees. Check your compass orientation by noticing where the Sun is. In the morning, it should be east or southeast. Around noon it should be south. Near sunset it should be west or southwest.

Where to Observe: Always observe from the same city. It is OK to shift your observing location a bit (to see around a building for example). If you cannot get to your regular observation city, just note the reason and do not observe on those days.

When to Observe: Try to observe at exactly the same clock time for at least 20 days. (*Note: If the time changes between standard time and daylight time, shift your observation time the same way as the clock time changes. For example, if you were observing at 10pm and clocks were turned ahead by an hour, you would then observe at 11pm by the new time.*) It is OK to skip a day or two but the total number of observation attempts should still be at least 20. Very often you will not see the Moon anywhere but those times still count and need to be recorded. Make enough observation attempts to see the Moon at least three times, even if that means making more than 20 attempts.

What to Report: For each observation attempt, indicate whether or not the moon was visible and what the weather was at that time (cloudy, rainy, clear, etc.). If the Moon was visible, report its azimuth and elevation. If the Moon was not visible, report what the weather was like.

What to Turn in: Your observations must be turned in as an Excel-compatible spreadsheet file set up as shown in the sample file available from the Projects link at our website. You may, in addition, turn in a document file (MS Word compatible) with a narrative description of your experiences. Either file may be extended with pictures and graphs if you wish. One good thing to add to the spreadsheet file is a scatter plot plot of elevation versus azimuth so that you can show how the Moon actually moves across the sky from night to night.

Preview Submission: By February 17, 2012, you should submit a spreadsheet file with at least two observation attempts. The purpose of the preview submission is to make sure that you have the format and online submission procedure right.

Final Submission: By April 13, 2012 you should submit a spreadsheet file with at least 20 observation attempts and at least 3 Moon measurements.

Project Preview Grading: The Project Preview adds up to one percentage point to your overall course grade and will be graded on a scale of 0 to 100 as follows:

1. 50 points for correct file format and submission procedure.
2. 20 points for making the observations. (Note that you can lose these points if you report seeing the Moon when it was not visible or report results that otherwise indicate that you did not do the observations.)
3. 20 points for following directions.
4. 10 points for added material such as a narrative or pictures of your instruments, or a graph of your spreadsheet.

Final Project Grading The final Project Submission adds up to four percentage points to your overall course grade and will be graded on a scale of 0 to 100 as follows:

1. 10 points for following the project directions.
2. 60 points for making the observations. (Note that you can lose these points if you report seeing the Moon when it was not visible or report results that otherwise indicate that you did not do the observations.)
3. 20 points for accuracy and consistency of results.
4. 10 points for added material such as a narrative or pictures of your instruments, or a graph of your spreadsheet.

Plagiarism: Do not copy someone else's observations. It is OK to work with others (especially since you will be out after dark). However *each person needs to make their own observations and do their own report. Duplicate reports will be regarded as evidence of an honor code violation.*