Project 1: Tracking the Sun

1 Your New Home Planet

You are a volunteer aboard a colony ship that has just landed on a planet in the Barnard's Star system, one of the closest stars to Earth. This planet turns out to be habitable, with a surface gravity very similar to that of Earth, and you and your fellow volunteers decide to settle there.

You have heard that this new solar system is extremely well ordered. Apparently all of the planets have circular orbits that lay in a common plane and are centered on the central star (Barnard's Star). Unfortunately, you don't have any detailed information about the planets in this solar system, including your new home planet. All of that information was lost in a computer malfunction on your colony ship.

You still have fond memories of that Copernican Revolution course you took back in college. In fact, you even brought your course materials (textbook and activity handouts) with you onto the colony ship. You decide that, armed with these materials, you will attempt to determine some important information about your home planet.

Your decide to start by observing the apparent motion of the Sun. You recall how much information can be gained by watching the shadows cast by a simple gnomon, so you set up a gnomon at your ship's landing site (Location 1 in the simulation). Using the shadows cast by this gnomon you can find out a lot about your home planet and your location on that planet. You then move 2500 miles to the South in order to make observations from a second site (Location 2). Finally, you will make observations from another location (Location 3). All of these observations will be made using your personalized Gnomon simulation.

2 What You Need To Do

2.1 On Earth

Before you start exploring your new planet, you need some practice here on Earth. You need to make two measurements of our Sun's altitude and azimuth. These two measurements should be made on the same day if at all possible, but at two significantly different times of day. There should be at least three hours between your two observations. You must make your measurements using the shadow of an object. You can choose any object you like, but you must be able to determine the height of the object and the length of the shadow. This measurements will be much easier if you use an object that is vertical, so that the shadow length can be measured from the base of the object to the tip of the shadow. The measurements will also be easier if the object is relatively straight and not too tall, so using a tree or a building might not work well. Feel free to find a stick and stick it in the ground, pointing straight up. Note that to determine the Sun's azimuth you will need to orient yourself by determining which direction is North. You can use known landmarks or some other method (the compass app on your phone, etc) to figure this out.

In your report make sure to include:

Setup A detailed explanation of your measurement setup, including what you used as your gnomon, how you determined its height, how you measured the length of shadows, and how you oriented yourself to North.

Altitude The altitude of the Sun (to the nearest degree) at your two times, as well as an explanation of how you determined these altitudes.

Azimuth The azimuth of the Sun (to the nearest degree) at your two times, as well as an explanation of how you determined these azimuths.

Comparison A comparison of the two Sun locations with comments about how the Sun moved across the sky from one time to the next.

2.2 On Your New Planet

Once you have figured out how to determine the altitude and azimuth of the Sun by measuring shadows, you can explore your new planet using the computer simulation you were given. For this project you need to complete the following tasks:

Verify North Use the Options menu to display the North arrow and then verify that it is, in fact, pointing North. Explain how you verified the direction of the arrow.

Locations Determine the longitude and latitude (to the nearest degree) of each of the three locations in the simulation. Clearly state whether each location is in the Northern or Southern hemisphere of your planet. Since longitude is measured from an arbitrary meridian, you should choose your meridian so that it passes through your ship's landing site (Location 1).

Radius of Planet Determine the radius of your planet in miles, to the nearest mile, using the method of Eratosthenes.

Local Noon Determine the time of local noon (to the nearest tenth of an hour) at each location.

Length of Day The length of a solar day, in hours (to the nearest tenth of an hour).

Length of Year The length of a tropical year, in solar days (to the nearest day).

Obliquity The obliquity (or tilt) of the ecliptic relative to the equator (to the nearest tenth of a degree).

Solstices and Equinoxes The day of the year for the vernal equinox, summer solstice, autumnal equinox, and winter solstice (to the nearest day). Also give the RA and Dec of the Sun on each of these dates.

Arctic/Antarctic Circles The latitude of the Arctic and Antarctic circles (to the nearest tenth of a degree).

Tropics The range of latitude for the tropics (to the nearest tenth of a degree).

3 Bonus

For two bonus points, clearly explain the problem with the Armillary Sphere in the classroom and describe in detail how the problem could be fixed.

4 Hints

You may carry out your tasks in any order that works. It may be easier to perform some tasks after you have already completed others. Do not assume that the list given above is in the easiest order. You should consult the following activities from class: The Celestial Sphere and the Motion of the Sun, The Celestial Globe, Shadows and Gnomons, and Eratosthenes Measures the Earth.

5 What You Need to Turn In

You must turn in a typed report that includes the following:

- One grammatically correct paragraph addressing *each* of the items in the previous section. **You must give the necessary numerical values (with units, if needed) AND an explanation of how you determined those values.** You may include sketches or diagrams (including printouts of plots from the simulation) if you wish. Please give each paragraph a heading, using the headings given above.

Please submit this project by September 23, 2013.