PHYS 101, Fall 2002
Homework #1 solutions
100 points possible
(#1-21pts, #2-30pts, #3-14 pts, #4-15 pts, #5-10 pts, #6-10 pts)

1. (a) See drawing on next page. The scale can be calculated in many ways. For example, the radius of the Earth on the homework assignment is about 3 mm. Then:

(Earth-to-Moon)/(radius-of-Earth) = 380,000/6400 = (scaled-Earth-to-Moon)/3mm

which gives the scaled Earth-to-Moon distance to be 178 mm. Using the same method, the scaled Moon radius is about 0.8 mm

(b) Again see the drawing on the next page. Several light rays emanating from the Moon (this light is reflected from the Sun--the Moon itself does not emit light) are shown. Notice that the rays that will hit the Earth are very nearly parallel.

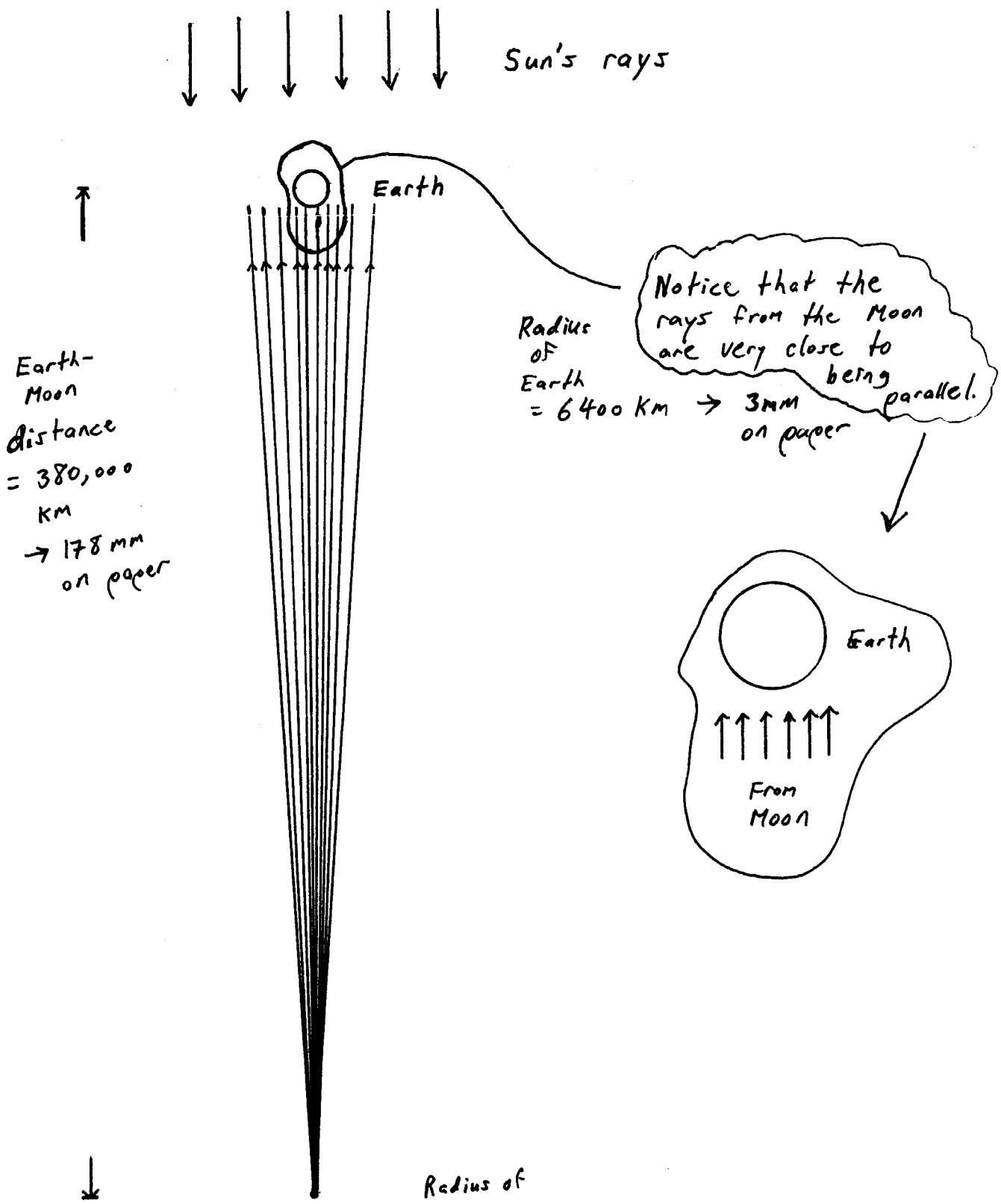
(c) The Earth does not usually block sunlight from hitting the Moon because the orbit of the Moon is tilted by about 5 degrees to the orbit of Earth around the Sun.

2. (a) With this approximation, sunrise occurs at 6 am and sunset is at 6 pm. These are the same everywhere on Earth because of time zones. That is, people at different longitudes have their clocks set differently precisely so that their clocks will read 6 am at sunrise at that location.

(b) From the Washington Post, sunrise and sunset for Washington D.C. on Sept. 23rd, 2002 were 6:56 am and 7:04 pm, Eastern Daylight Time. Subtract an hour to get standard time: 5:56 am and 6:04 pm. These are very close to the 6 am and 6 pm times in part (a), which uses the approximation that the Earth is not tilted. This is no surprise, because the effective tilt of the Earth is small in September (and in March). But it's large in December and June, so we'd expect the approximation to be worse at those times.

(c) You should show your work for at least one of these. As you proved in problem one, the Moon's rays are nearly parallel when they hit the Earth. For the Moon in position A, the rays from the Moon would first skim the surface of the Earth at noon, and last until midnight. So moonrise is (approximately) noon and moonset is at midnight.

position B: 6 pm to 6 am
position C: midnight to noon
position D: 6 am to 6 pm


Sun's rays
Earth
Earth-
Moon
distance
= 380,000
km
→ 178 mm
on paper
Radius
of
Earth
= 6400 km → 3mm
on paper
Notice that the
rays from the Moon
are very close to
being
parallel.
Earth
From
Moon
Radius of
Moon =
1740 km → 0.8 mm on
paper

(d) You must sketch these.

position A: half-illuminated on the right
position B: full moon (full illumination)
position C: half-illuminated on the left
position D: new moon (no illumination)

(e) If the Moon is half-illuminated on the left (as viewed from Charlottesville), it is in position C on our sketch, which means it rises at about midnight in the East, and sets at noon in the West. At 6 am it will be at its highest point for the day, in the southern sky, and at 9 am it will be about halfway between its highest point and setting. So at 9 am it will still be fairly high in the sky, and towards the southwest.

3. (a) As viewed from above the North pole, Earth rotates counter-clockwise.

   (b) You must sketch this to receive full credit. Just like the Sun and the Moon, the planets are so far away that their light rays arrive nearly parallel. If you draw these, you'll see that Planet A rises at about 2 am or 3 am, and sets at about 2 pm or 3 pm, and Planet B rises at about 8 am or 9 am, and sets at about 8 pm or 9 pm. You can be off a little from these answers, but you must have shown a sketch to justify your answers.

4. In Ptolemy's Earth-centered model, Venus was never very far from being along a line between the Earth and the Sun. It could deviate somewhat from this line because of its "epicycle", or small circular orbit on top of its big circular orbit around the Sun (see page 14 of Hobson). Even with this epicycle, though, Venus should at most be slightly illuminated on the left or right, but mostly not illuminated at all, and certainly never "full" (see page 20). In the Sun-centered model of Copernicus, on the other hand, the Sun could come between the Earth and Venus (see page 19) so Venus could appear "full." After his construction of a crude telescope, Galileo observed the "full" Venus and therefore disproved the Earth-centered theory.

5. Mars goes more slowly in its orbit than does Earth, so eventually all relative positions of Mars and Earth will be found. So to consider this question, pretend that the Earth is at rest and Mars goes around in its orbit. Since its orbit is larger than Earth's, it will never come between the Sun and the Earth. Because of this, we will never see a "new" Mars, but we will see a "full" Mars and some of the intermediate phases.

6. (Measure the angle of the Sun above the horizon between 12:30 pm and 1:30 pm in Charlottesville. State location, time, date, and show method.)
   You must show your work to receive full credit. You must also be close to the correct answer. If you're careful you should be within 1 or 2 degrees, but a bit more is acceptable for this first assignment. Here are some sample dates:

   Sept. 1: about 60 degrees Sept. 12: about 56 degrees Sept. 18: about 54 degrees