ASTR 2000 HOMEWORK #4 DUE THURS OCTOBER 1 NAME: _Francis Scott Key__

1. (10 points; 2 points each part) It is four (4) days BEFORE the full Moon in mid-November on an unspecified year here in Boulder. You are standing in Norlin Quadrangle looking due south at the Moon as it crosses the local meridian. INFO IN BRACKETS [ ] NOT REQUIRED

a. Sketch the appearance of the Moon at the time above. Shade the dark portion so there is no ambiguity as to the phase. What is this phase of the Moon called?

Waxing Gibbous

[time ~ 9pm local time]

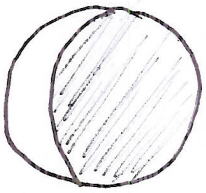
b. How many days is it until the next **New Moon**?

4 days + 14—15 days (Full to New Moon) = 18—19 days

c. Two weeks after the observation you made in part (a) you return to Norlin Quad and again observe the Moon as it crosses the local meridian. Sketch the appearance of the Moon. What do we call this phase?

Waning Crescent

[time ~ 9am local time]

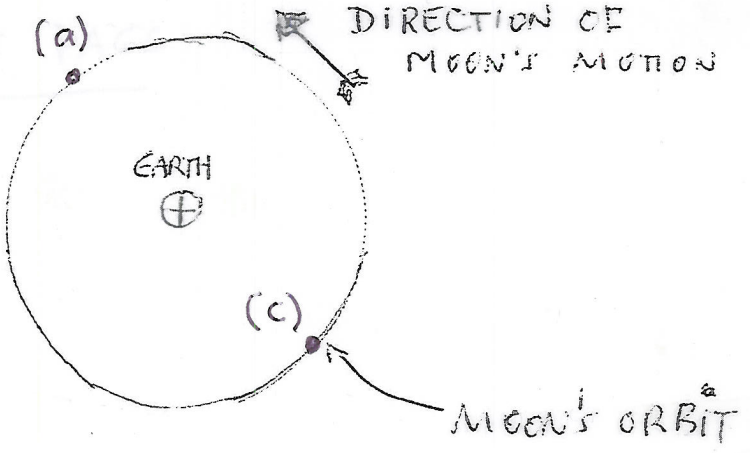


[i.e. the "reverse" of the sketch above]

d. On the sketch of the orbit of the Moon shown below {NOT TO SCALE!}, place these two moon phases at their approximate correct locations in the lunar orbit. Use the letters (a) and (c) to indicate the Moon's location in parts (a) and (c).

SKETCH LOOKING DOWN ON MOON'S ORBIT FROM ABOVE THE ECLIPTIC PLANE

NOT TO SCALE



e. Use your two sketches from parts (a) and (c) to explain the difference between the "back-side" of the Moon and the "dark-side" of the Moon.

Both lunar phases sketched have portions of the dark-side and bright-side hemispheres visible. Both lunar phases sketched (and, in fact, any lunar phase observed at ANY time is of the front-side of the Moon).

The back-side of the Moon is the hemisphere we can never see from Earth, Just like the front-side hemisphere, the back-side hemisphere alternates between darkness and light like the hemispheres on the Earth. The dark-side hemisphere faces away from the Sun and over a 29.5 day period the darkness swings through all the lunar longitudes (i.e., all lunar geography).

2. (10 points; 2 points each part) When does the **waxing half Moon** (also called first quarter moon) rise? You could look up the answer in the notes but, by going through the step-by-step process suggested below, you will both answer this question and learn how to answer similar questions.

a. It's a half Moon, so how far from the source of light (the Sun) is the Moon in the sky? (How many degrees or what fraction of a full circle of 360 degrees is this angle approximately?). A glance at the sketch of the lunar orbit in Question 1 part (d) may help you answer this question.

90 degrees or ¼ circle since it is ¼ the way around the lunar orbit from New Moon, which is in the direction of the Sun.

b. Now how many hours of Earth's rotation does this many degrees (or this many fractions of a full circle) correspond to? That is, _90_degrees (from above) is to 360 degrees as _6_hours is to 24 hours. Fill in the blanks.

Now you know by how many hours the Moon leads or follows the Sun in the sky when it is at this phase.

c. It's a waxing Moon, so does it lead (i.e., is it to the right of) or follow (i.e., to the left of) the Sun? Circle one of these options and explain your answer.

Follow because it is to the left of the Sun at sunset, following it down in the sky as the Earth rotates.

d. So, now you are done. Just put all your answers together and answer the first question relative to Sunrise. {For example, if your answer to part (c) is "leads" and your answer to part (b) is 10 hours, then Moonrise precedes Sunrise by 10 hours. Ten hours before Sunrise is also about 2 hours after Sunset the previous day or approximately 8pm}. So, using your answers to parts (b) and (c), at approximately what time does the waxing half Moon rise?

The Waxing Half Moon follows the Sun down by 6 hours and so would rise when Sun is near **NOON**.

e. Go through this same logic again to estimate the approximate time the **waning half Moon** (third quarter Moon) **sets**.

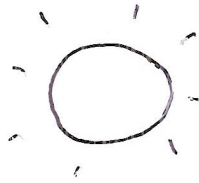
Waning half moon precedes the Sun by 6 hours. And so it sets 6 hours before the Sun sets, i.e., the waning half Moon sets at about **NOON**.

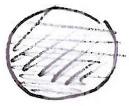
3. (10 points) The Moon's orbit around the Earth is tilted by 5° from the ecliptic plane (the plane of the Solar System and of the Sun's orbit around the Earth from the perspective of the ancients). This tilt has several observational consequences.

a. (4 points) Explain with a sketch **and** words why this tilt prevents either a Solar Eclipse or a Lunar Eclipse from occurring every month.

The Moon's orbit is tilted by 5 degrees with respect to the ecliptic so when it is at its Full or New Moon position it is usually either above or below the ecliptic. Since the Sun and Moon are only ½ degree in the sky, 5 degrees carries the Moon far enough away from the ecliptic so the Sun is not blocked and no eclipse occurs.

FOR EXAMPLE AT : NEW MOON IN SKY

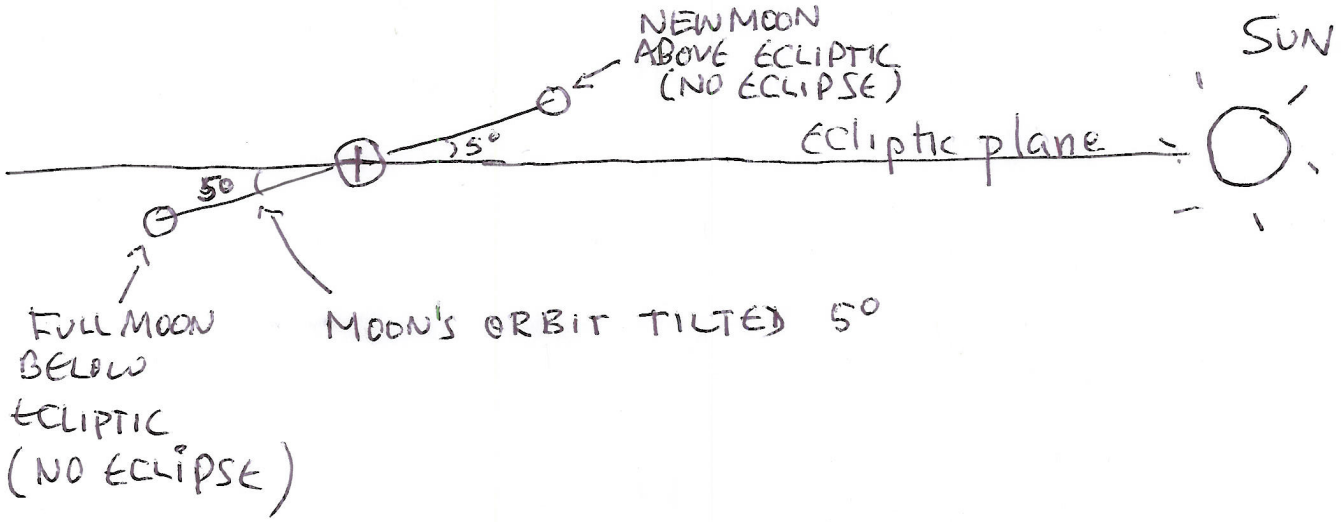




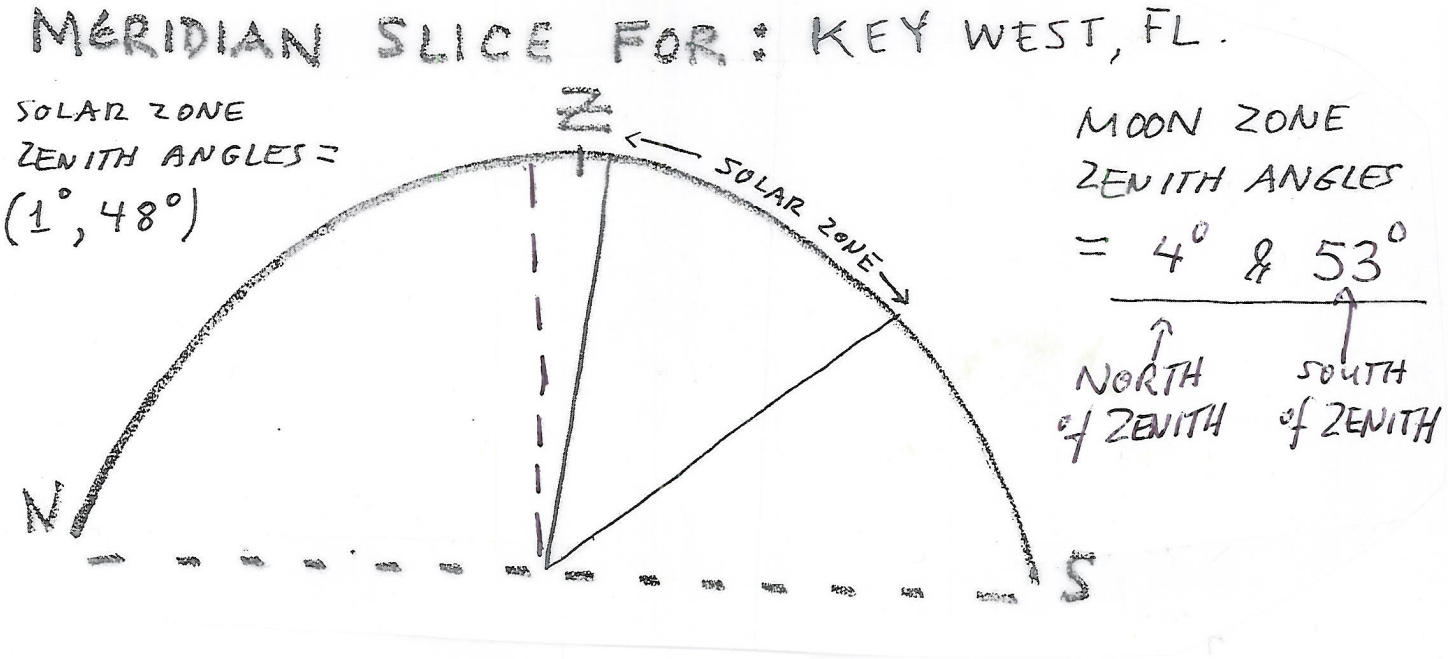
GO TO NEXT PAGE for PARTS b. and c.

OR [NOT TO SCALE]

AN "EDGE-ON" VIEW :



b. (4 points) The 5° tilt also increases the full range of Celestial Latitudes (Declinations) that the Moon can have. In comparison with the Sun's range of 47° (twice 23.5°), the Moon has a full range of 47° + 10° = 57°. The sketch below is a meridian slice for Key West, FL (latitude = 24.5° N) showing the "Solar Zone" for that location. On this slice show the range of angles along the meridian that the Moon can have, a range that we might call the "Moon Zone". Compute the zenith angles for the extreme locations of the Moon within its "Zone". Specifically for the Full Moon what are these extremes called?



These extremes are called the Major Standstills of the Moon.

c. (2 points) In observing the Moon what can happen in Key West, FL that cannot happen ever here in Boulder? Explain your answer. {Presumably lots of things can happen in Key West that don't happen here but have nothing to do with the Moon!}

At or near its extreme northern position the Moon can go directly overhead, through the zenith at Key West. This can never happen in Boulder.

[The Full Moon attains the extreme location only for the Full Moon closest to the winter solstice. Its highest point, declination = 28.5 degrees happens (4 degrees NORTH of the zenith at Key West) only every 19 years but about half of the winter solstice Full Moons go through the zenith or just north of the zenith in Key West; the other 9 years the winter solstice Full Moon crosses the meridian in Key West just south of directly overhead.]