INST 2403

The Moon's Phases

The Moon's phases are a result of the relative position of the three objects sun, moon and Earth (observer). In particular, the moon is always half lit up by the sun (day side) and half in the dark (night side). The observer on earth sees different fractions of the dark and illuminated sides at different times. The moon orbits the earth counterclockwise.

1. With a pencil color in the dark parts of Earth and Moon (8 circles). see figure
2. Indicate the time for an observer at different spots on the earth in 6 hour increments starting from noon (You know when/where noon occurs!). see figure
3. Identify the phases of the moon in the 8 positions shown.
4. At what time of the day is the waning gibbous moon at the meridian, i.e. highest daily altitude?

   3 am. (see figure)

5. Can a person at noon see the first quarter moon? If yes: where in the sky? If no: why not?

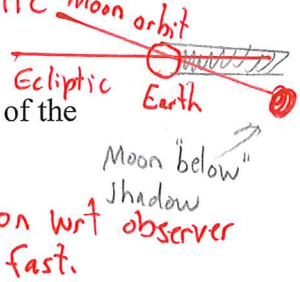
   Yes, it is just rising at the eastern horizon.

6. Draw the shadows cast by the earth and the new moon into the figure. see figure
7. During what phase could the shadow of the earth fall onto the moon?

   Full moon phase only.

8. This is called a lunar eclipse. Why does it not happen once a month?

   Because the moon's orbit is inclined wrt the ecliptic (orbital plane of Earth around the sun)



9. Say the moon is in its waxing crescent phase when it rises. What will the phase of the moon be when it sets?

   Also waxing crescent; phases change slowly, position wrt observer fast.

10. How much of the entire surface of the moon is illuminated during the crescent phase?

    Half, as always.

11. When does the new moon rise, when does it set?

New moon is in direction of sun, so "does what the sun does".
→ Rises at sunrise (6am, idealized), sets at sunset (6pm, idealized)

12. Where in the sky does the new moon rise, where does it set?

Everything rises in the east, and sets in the west.

13. When does a last quarter moon rise, when does it set?

LQ moon is highest in the sky at 6am, rises 6hrs earlier (midnight) and sets 6 hrs later (noon).

14. Where in the sky does the last quarter moon rise, where does it set?

See 12: east & west.

15. How far apart in the sky are the last quarter moon and the sun?

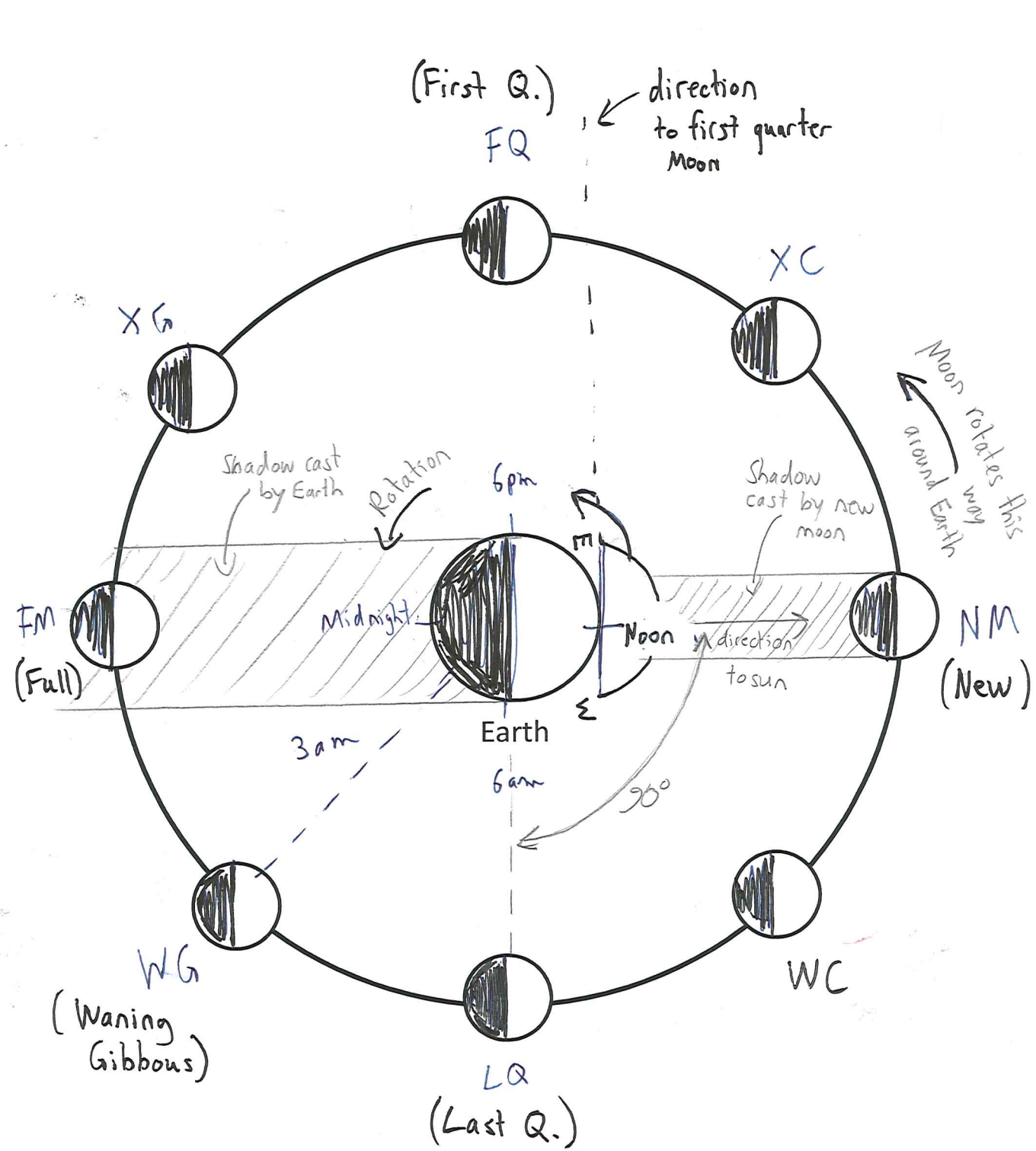
Use figure like a protractor: 90° (or 270°)

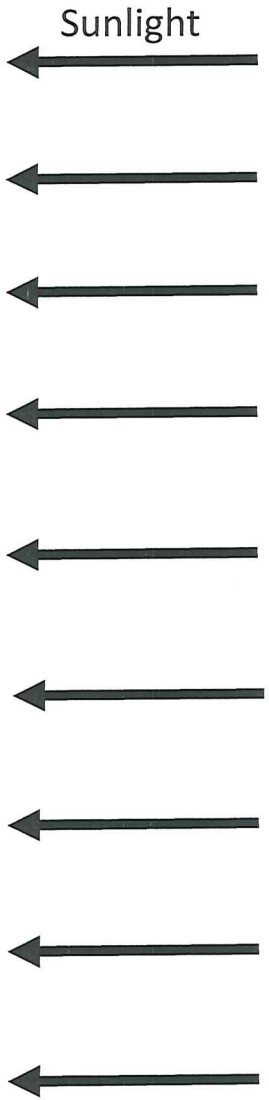
Also: 12pm and 6am are 6hrs (18hrs) apart, which is $\frac{6}{24} = \frac{1}{4}$ ($\frac{18}{24} = \frac{3}{4}$) and $\frac{1}{4} \times 360° = 90°$

$\frac{3}{4} \times 360° = 270°$

16. How far apart in the sky are the full moon and the sun?

They are opposite, so 180°.


(First Q.)
FQ
direction to first quarter Moon
XC
XG
Moon rotates this way around Earth
Shadow cast by Earth
Rotation
6pm
Shadow cast by new moon
FM
(Full)
Midnight
Noon
direction to sun
NM
(New)
Earth
3am
6am
90°
WG
(Waning Gibbous)
WC
LQ
(Last Q.)


Sunlight