## PROBLEM SET 2 SOLUTIONS Physics 2021

1. If phases are caused by the Earth's shadow, the curved terminator on the crescent and gibbous moons would indicate that both edges of the Earth are curved.
However, at the quarter phases the terminator is straight, and the Earth's curved body could not cast a straight-edged shadow.

2a. Full Moon
2b. Third Quarter
2c. New Moon
2d. First Quarter

3a. Third Quarter
3b. New Moon
3c. First Quarter
3d. Full Moon
(Hint: There is a 6-hour difference from when the Moon rises to when it is highest in the sky.)
4. The orbital velocity of the Moon is $\mathbf{3 6 0}$ deg in 27.3 days.
a. $\quad t=\mathbf{d} / \mathbf{v}=(0.5 \mathrm{deg}) /(360 \mathrm{deg} / 27.3$ day $)$
$=(0.5 \mathrm{deg} / 360 \mathrm{deg})(27.3$ day * $24 \mathrm{hr} /$ day $)=0.91 \mathrm{hr}$
b. $\quad d=(0.5 \mathrm{deg} / 0.91 \mathrm{hr})(12 \mathrm{hr})=6.6 \mathrm{deg}$
5. The Moon covers $360^{\circ}$ in one sidereal month

$$
=27 \text { days } 7 \text { hours } 43 \mathrm{~min}=2.36 \times 10^{6} \mathrm{sec}
$$

$$
\begin{aligned}
& \text { Angular Speed }=360^{\circ} / 2.35 \times 10^{6} \mathrm{sec} \\
& \text { Angular Diameter }=\text { Angular Speed } \times \text { Time }=(90 \mathrm{sec})\left(360^{\circ} / 2.35 \times 10^{6} \mathrm{sec}\right) \\
& \quad=0.0137 \mathrm{deg}=49 \mathrm{arcsec}
\end{aligned}
$$

6. Because it takes almost 30 days for the Moon to complete a cycle, it is hard to get 2 Full Moons to fit in months that are only 30 or 31 days long. February cannot have a Blue Moon because it is too short to have even a complete lunar cycle.
7. From our perspective as we look up at the sky, we see the Moon always moving from the West toward the East. Therefore, we would see the Moon enter the Earth's shadow from the West side and exit on the East side.

8a. If the Moon's diameter were doubled, there would be more total solar eclipses because the opportunity to cover the Sun's disk would be increased.

8b. If the Moon's diameter were halved, then there would be no total solar eclipses because the Moon would not be large enough to cover the Sun's disk completely. Each eclipse that is now total would become an annular eclipse.
9. To have the maximum duration of totality, you want the Sun to appear as small as possible. Therefore, the distance should be a maximum, i.e., aphelion.

