

## PROBLEM SET 2

### Physics 2021

1. The dividing line between the illuminated and unilluminated halves of the Moon is called the *terminator*. The terminator appears curved when there is a crescent or gibbous moon, but is straight when there is a first or third quarter moon. Describe how you could use these facts to explain why lunar phases cannot be caused by the Earth's shadow falling on the Moon.
2. What is the Moon's phase if it is on the meridian at (a) midnight; (b) sunrise; (c) noon; (d) sunset?
3. What is the phase of the Moon if it rises at (a) midnight; (b) sunrise; (c) noon; (d) sunset? How much time elapses from when the Moon rises to when it is highest in the sky?
4. (a) Calculate how long it takes the Moon to move through an angle equal to its own angular diameter ( $1/2^\circ$ ) against the background of stars. Give your answer in hours. (b) Through what angle (in degrees) does the Moon move during a 12-hour night? Use 27.3 days for the Moon's orbital period.
5. During an occultation of Jupiter by the Moon, an astronomer notices that it takes the Moon's edge 90 seconds to cover Jupiter's disk completely. If the Moon's motion is assumed to be uniform and the occultation was "central" (that is, center over center), find the angular diameter of Jupiter. (*Hint*: Assume that Jupiter does not appear to move against the background of stars. Convert the Moon's angular speed from degrees per day to arcseconds per second.)
6. One definition of a "blue moon" is the second full moon with the same calendar month. There is usually only one full moon within a calendar month, so the phrase "once in a blue moon" means "hardly ever." Why are blue moons so rare? Are there any months of the year in which it would be impossible to have two full moons? Explain your answer.
7. You are watching a lunar eclipse from some place on the Earth's night side. Will you see the Moon enter the Earth's shadow from the east or from the west? Explain your reasoning.
8. (a) Suppose the diameter of the Moon were doubled, but the orbit of the Moon remained the same. Would total solar eclipses be more common, less common, or just as common as they are now? Explain. (b) Suppose the diameter of the Moon were halved, but the orbit of the Moon remained the same. Explain why there would be *no* total solar eclipses.
9. Just as the distance from the Earth to the Moon varies somewhat as the Moon orbits the Earth, the distance from the Sun to the Earth changes as the Earth orbits the Sun. The Earth is closest to the sun at its *perihelion*; it is farthest from the Sun at its *aphelion*. In order for a total solar eclipse to have the maximum duration of totality, should the Earth be at perihelion or aphelion? Assume that the Earth-Moon distance is the same in both situations. As part of your explanation, draw two pictures, one with the Earth relatively close to the Sun and one with the Earth relatively far from the sun.