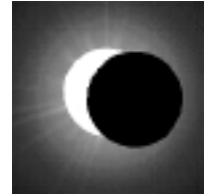


1. The moon is in its _____ phase during a $\left[\begin{array}{l} \text{lunar} \\ \text{solar} \end{array} \right]$ eclipse.

- (A) new.
- (B) first quarter.
- (C) full.
- (D) third quarter.
- (E) (Depends on the time of day.)
- (F) (Unsure/guessing/lost/help!)

2. The picture shown at right depicts the moon and the sun, as seen from an observer located in:

- (A) the moon's umbra.
- (B) the moon's penumbra.
- (C) the moon's negative shadow.
- (D) Earth's umbra.
- (E) Earth's penumbra.
- (F) (Unsure/guessing/lost/help!)



3. In November 2006 the planet Mercury was seen¹ as a tiny dark dot in the middle of the disk of the sun by observers in San Luis Obispo, CA², who were located in:

- (A) Mercury's umbra.
- (B) Mercury's penumbra.
- (C) Mercury's negative shadow.
- (D) Earth's umbra.
- (E) Earth's penumbra.
- (F) (Unsure/guessing/lost/help!)

4. $\left[\begin{array}{l} \text{A total lunar eclipse does not occur every full moon} \\ \text{A total solar eclipse does not occur every new moon} \\ \text{Some solar eclipses are annular rather than total} \end{array} \right]$ because:

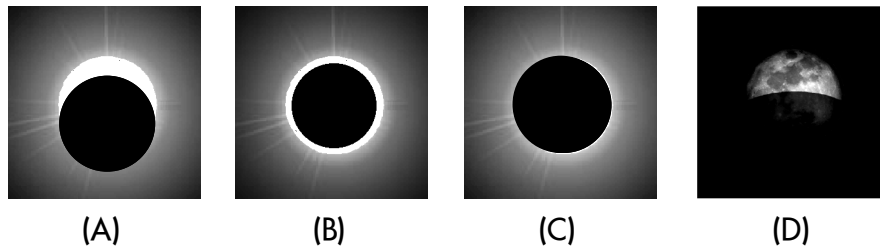
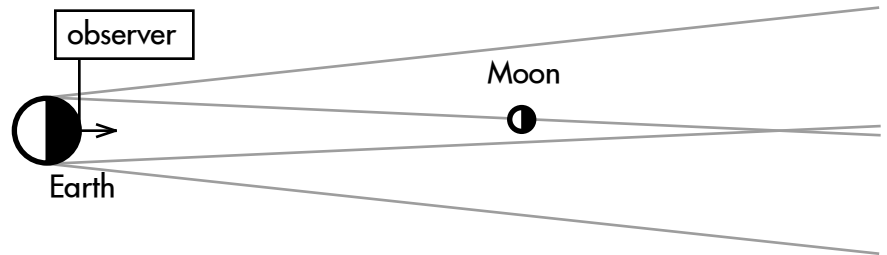
- (A) the moon's orbit around Earth is tilted.
- (B) the moon's orbit is not a perfect circle.
- (C) the moon always keeps the same side facing Earth.
- (D) Earth's axis precesses over a 23,000 year cycle.
- (E) (Unsure/guessing/lost/help!)

¹ eclipse.gsfc.nasa.gov/OH/transit06.html.

² [flic.kr/p/yc6mv](https://www.flic.kr/p/yc6mv).

5. During a total $\begin{matrix} \text{lunar} \\ \text{solar} \end{matrix}$ eclipse seen by observers in San Luis Obispo, CA, observers on the side of the moon facing Earth would see:
- (A) Earth completely blocking the sun.
 - (B) the sun, with part of it being blocked by Earth.
 - (C) the sun, with no part of it being blocked by Earth.
 - (D) Earth, with the moon's shadows on it.
 - (E) Earth, completely illuminated by the sun.
 - (G) (Unsure/guessing/lost/help!)

6. A side view of Earth and its shadow zones, the location of an observer on Earth, and the moon is shown below. The sun is located to the left, far off of the page. Which view does this observer see?



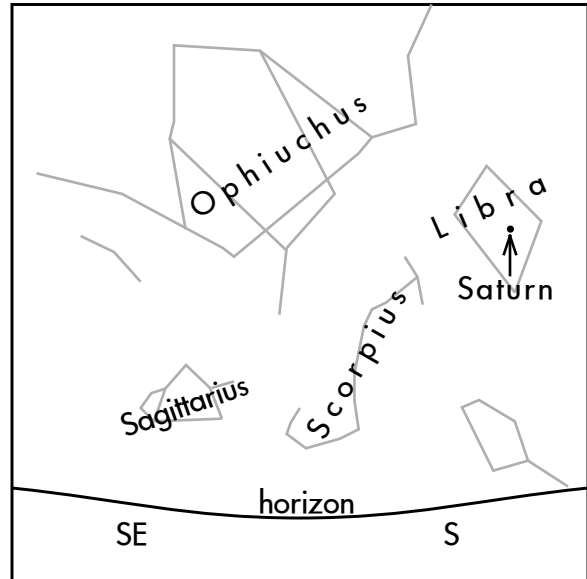
- (E) (Unsure/guessing/lost/help!)

7. If the moon is located entirely within Earth's $\left[\begin{array}{c} \text{umbra} \\ \text{penumbra} \end{array} \right]$, an observer on the the side of Earth facing the moon would see:
- (A) the entire sun blocked by a new moon.
 - (B) only part of the sun blocked by a new moon.
 - (C) a new moon not large enough to entirely block the sun while in front of it.
 - (D) a very, very dark brown-red full moon.
 - (E) a dark shadow across part of a full moon.
 - (F) a full moon slightly dimmer than usual.
 - (G) (Unsure/guessing/lost/help!)
8. In December 2011, when observers in Seattle, WA watched a total lunar eclipse³, at the same time observers in San Luis Obispo, CA would have seen a:
- (A) total lunar eclipse.
 - (B) partial lunar eclipse.
 - (C) total solar eclipse.
 - (D) partial solar eclipse.
 - (E) normal full moon.
 - (F) (Unsure/guessing/lost/help!)
9. In August 2017, observers in different neighborhoods of St. Louis, MO saw a partial solar eclipse or a total solar eclipse⁴, depending on whether they are located in the moon's _____ or _____, respectively.
- (A) negative shadow; penumbra.
 - (B) negative shadow; umbra.
 - (C) penumbra; negative shadow.
 - (D) penumbra; umbra.
 - (E) umbra; negative shadow.
 - (F) umbra; penumbra.
 - (G) (Unsure/guessing/lost/help!)

³ eclipse.gsfc.nasa.gov/OH/OHfigures/OH2011-Fig06.pdf.

⁴ eclipse2017.org/2017/maps/cities/STL.htm.

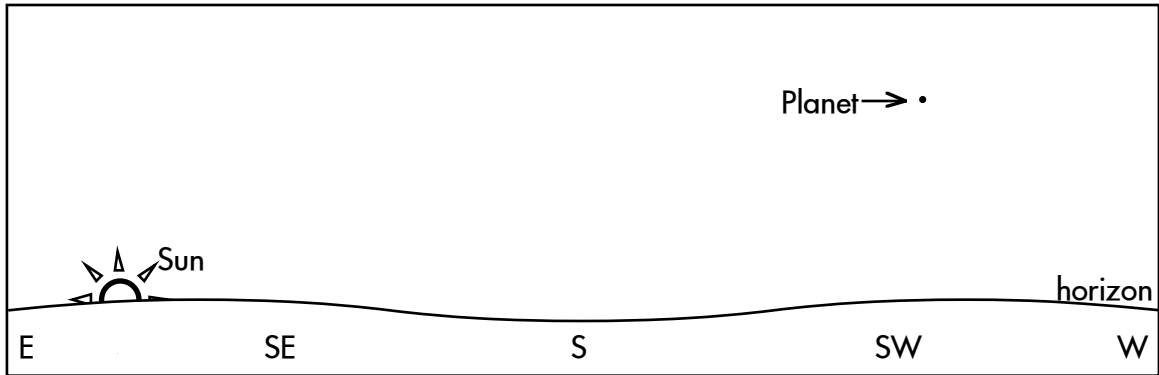
The diagram at right shows Saturn's position in the constellation Libra as seen by an observer tonight in San Luis Obispo, CA. During this month Saturn is undergoing $\left[\begin{array}{l} \text{retrograde} \\ \text{prograde} \end{array} \right]$ motion.



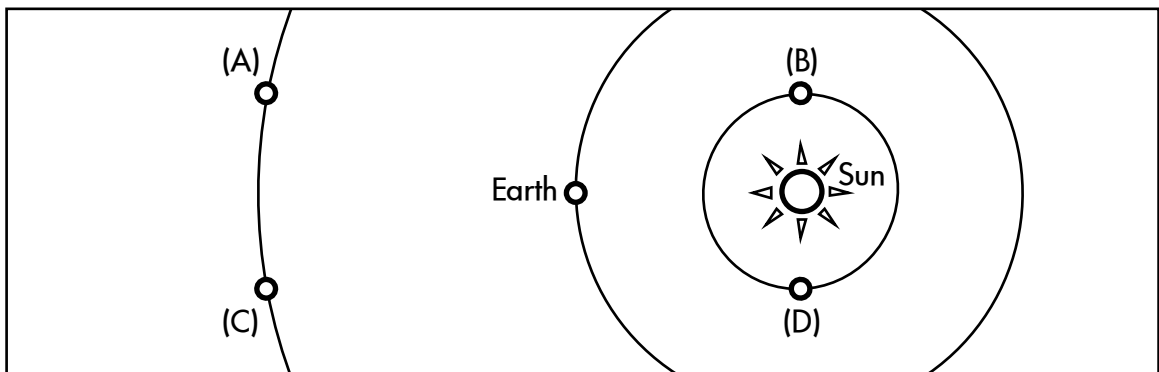
10. Over the course of this night Saturn would rise in the _____ and set in the _____.
- (A) east; west.
 (B) east; east.
 (C) west; east.
 (D) west; west.
 (E) (Unsure/guessing/lost/help!)
11. The following night Saturn will be _____ this position in the constellation Libra.
- (A) slightly to the left of.
 (B) slightly to the right of.
 (C) exactly at.
 (D) (Not visible at all the following night.)
 (E) (Unsure/guessing/lost/help!)

12. In general, $\left[\begin{array}{l} \text{inner planets (Mercury and Venus)} \\ \text{outer planets (Mars, Jupiter, and Saturn)} \end{array} \right]$ could be visible somewhere in the San Luis Obispo, CA sky at:
- (A) sunset.
 (B) midnight.
 (C) sunrise.
 (D) (Two of the above choices.)
 (E) (All of the above choices.)
 (F) (None of the above choices.)
 (G) (Unsure/guessing/lost/help!)

13. A view of the horizon is shown below, as seen from San Luis Obispo, CA. Carefully note the positions of the sun, and an unknown planet in the sky.

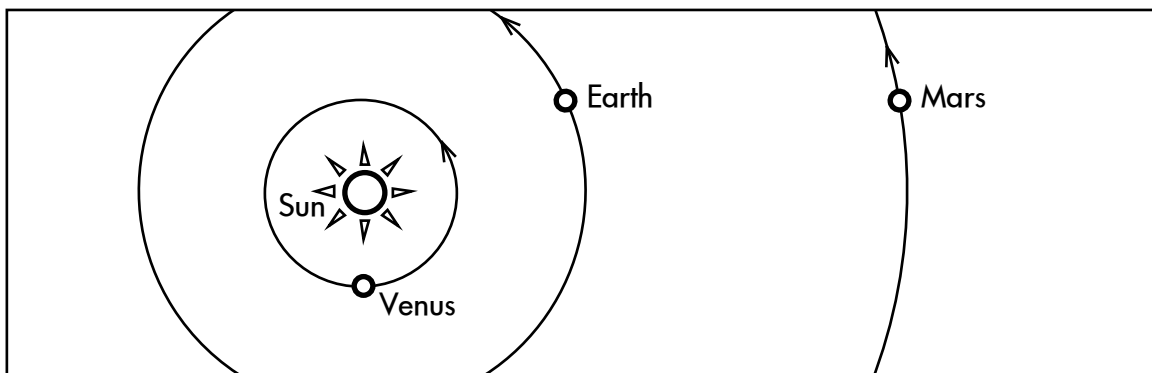


The planet shown above corresponds to which location (A)-(D) on the diagram below (not to scale, and orbits have been simplified as circles instead of ellipses)?



(E) = (Unsure/guessing/lost/help!)

The locations of Venus, Earth, and Mars, are shown in the diagram below (not to scale, and orbits have been simplified as circles instead of ellipses).



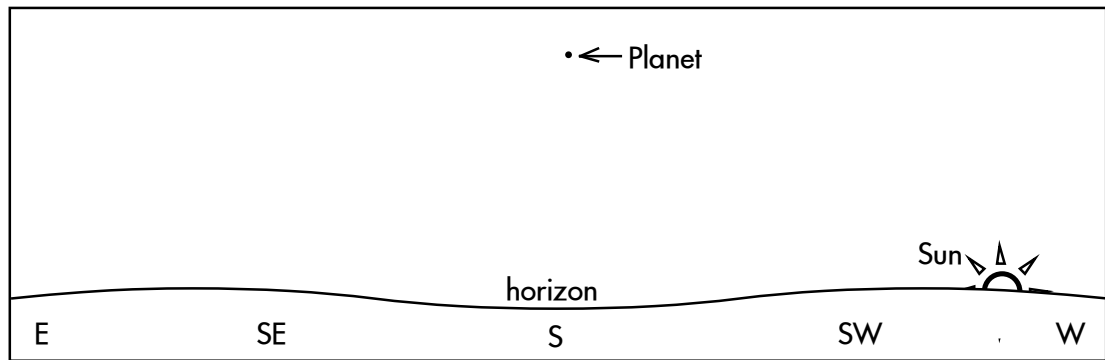
14. At $\begin{bmatrix} \text{sunset} \\ \text{midnight} \\ \text{sunrise} \end{bmatrix}$, $\begin{bmatrix} \text{Venus} \\ \text{Mars} \end{bmatrix}$ will be:

- (A) low over the east horizon.
- (B) somewhere high up in the sky.
- (C) low over the west horizon.
- (D) not visible in the sky.
- (E) (Unsure/guessing/lost/help!)

15. Mars is _____ retrograde motion.

- (A) about to start.
- (B) in the middle of.
- (C) just completing.
- (D) (Unsure/guessing/lost/help!)

16. A view of the horizon is shown below, as seen from San Luis Obispo, CA. Carefully note the positions of the sun, and an unknown planet in the sky.



- At sunrise, this planet will be:
- (A) low over the east horizon.
 - (B) somewhere high up in the sky.
 - (C) low over the west horizon.
 - (D) not visible in the sky.
 - (E) (Unsure/guessing/lost/help!)

17. Which of the following choices (A)-(D) below depicts Mars just

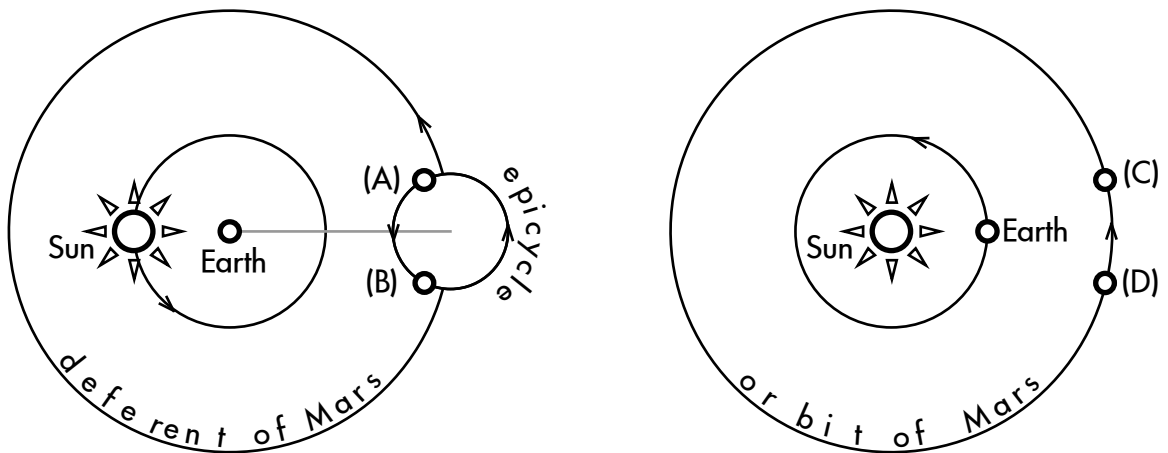
starting
ending

 its retrograde motion, in the

Ptolemaic
Copernican

 model of planetary motion, as seen from Earth?

(These drawings are not to scale, and represent simplified models.)

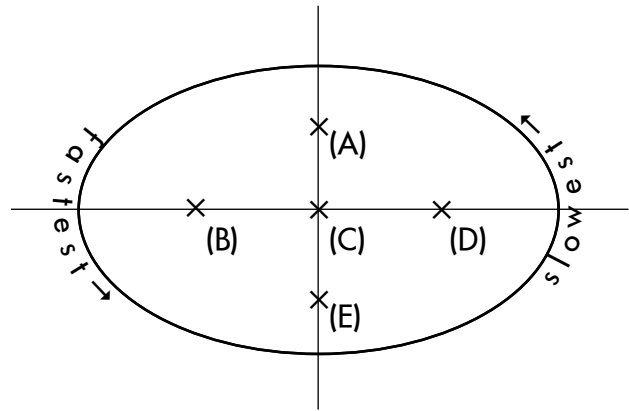


- (E) = (Unsure/guessing/lost/help!)

18. Who $\left[\begin{array}{l} \text{made observations that disproved Earth as the center of motion in the universe} \\ \text{accurately described planetary motion without explaining why it occurs} \\ \text{developed laws relating the motion of a body to the forces acting on it} \end{array} \right] ?$
- (A) Aristotle.
 - (B) Ptolemy.
 - (C) Copernicus.
 - (D) Tycho.
 - (E) Kepler.
 - (F) Galileo.
 - (G) Newton.
 - (H) (Unsure/guessing/lost/help!)
19. Aristotle based his model of the universe on *first principles*, which:
- (A) are ideas accepted as truth without further examination.
 - (B) are predictions that could be tested by observations.
 - (C) are universal statements of cause and effect.
 - (D) describe phenomena without explaining why it occurs.
 - (E) (Unsure/guessing/lost/help!)
21. $\left[\begin{array}{l} \text{Ptolemy's} \\ \text{Copernicus'} \end{array} \right]$ model explained prograde and retrograde motions of a planet by:
- (A) disregarding parallax.
 - (B) moving it on a circle that itself moves around Earth.
 - (C) using an elliptical instead of a circular orbit.
 - (D) having it orbit at a different speed than Earth's orbit around the sun.
 - (E) (Unsure/guessing/lost/help!)
22. Ptolemy's and Copernicus' models of planetary motion were equally inaccurate because they both:
- (A) included uniform circular motion.
 - (B) were based on ancient data with errors.
 - (C) assumed perfect and unchanging heavens.
 - (D) did not include tides.
 - (E) (Unsure/guessing/lost/help!)

23. Tycho disproved that the heavens were perfect and unchanging by:
- (A) not detecting any parallax for a new star.
 - (B) observing the motion of Jupiter's satellites.
 - (C) explaining how the moon creates ocean tides.
 - (D) losing his nose in a duel defending the principles of science.
 - (E) (Unsure/guessing/lost/help!)
24. Kepler's laws are *empirical*, because they:
- (A) are accepted as truth without further examination.
 - (B) make predictions that could be tested by observations.
 - (C) are universal statements of cause and effect.
 - (D) describe phenomena without explaining why it occurs.
 - (E) (Unsure/guessing/lost/help!)
25. Kepler's _____ contradicts $\left[\begin{array}{l} \text{uniform motion} \\ \text{perfect circles} \end{array} \right]$.
- (A) first law (orbits of the planets are ellipses with the sun at one focus).
 - (B) second law (a line from a planet to the sun sweeps over equal areas in equal intervals in time).
 - (C) third law (a planet's orbital period squared is proportional to its average distance from the sun cubed).
 - (D) (None of the above choices.)
 - (E) (Unsure/guessing/lost/help!)
26. According to Kepler's _____, a planet in an elliptical orbit will move most rapidly when it is closest to the sun.
- (A) first law (orbits of the planets are ellipses with the sun at one focus).
 - (B) second law (a line from a planet to the sun sweeps over equal areas in equal intervals in time).
 - (C) third law (a planet's orbital period squared is proportional to its average distance from the sun cubed).
 - (D) (None of the above choices.)
 - (E) (Unsure/guessing/lost/help!)

27. Shown at right is the elliptical orbit of a planet, which moves at different speeds along its orbit. According to Kepler's laws, where must the sun be located?



(F) (Unsure/guessing/lost/help!)

28. Galileo's observations of the moons of Jupiter supported the heliocentric model of planetary motion over the geocentric model because:
- (A) no parallax was observed.
 - (B) their orbits were elliptical instead of circular.
 - (C) it showed that epicycles and deferents were not real.
 - (D) there could be centers of motion other than Earth.
 - (E) (Unsure/guessing/lost/help!)
29. Galileo proved that Venus revolved around the sun by observing its:
- (A) moons' orbital periods.
 - (B) complete set of phases.
 - (C) prograde and retrograde motion.
 - (D) non-uniform, non-circular motion.
 - (E) (Unsure/guessing/lost/help!)
30. Galileo was tried and condemned by the Inquisition for:
- (A) inventing the telescope.
 - (B) believing Earth moved around the sun.
 - (C) using observations to contradict teachings of the Church.
 - (D) translating and publishing Copernicus' *De Revolutionibus* in Italian.
 - (E) (Unsure/guessing/lost/help!)

31. Newton's _____ says that nature is *rational* (depends on cause and effect).
- (A) first law (a body continues at rest, or uniform motion in a straight line unless acted upon by some force).
 - (B) second law (a body's change of motion is proportional to the force acting on it and is in the direction of the force).
 - (C) third law (when one body exerts a force on a second body, the second body exerts an equal and opposite force back on the first body).
 - (D) (None of the above choices.)
 - (E) (Unsure/guessing/lost/help!)
32. Newton's laws remade astronomy into an analytical science because these laws make predictions that:
- (A) could be tested by observation.
 - (B) describe motion without explaining why it occurs.
 - (C) deduced truth about the universe from first principles.
 - (D) the universe is perfect and unchanging.
 - (E) (Unsure/guessing/lost/help!)
-

(Subjective)

33.

Aristotle	was a:
Ptolemy	
Copernicus	
Tycho	
Kepler	
Galileo	
Newton	
- (A) "mover" (developed models to describe/explain planetary motion).
 - (B) "disprover" (gathered/used evidence to refute a model of planetary motion).
 - (C) (Both of the above choices.)
 - (D) (Neither of the above choices.)
 - (E) (Unsure/guessing/lost/help!)

(Subjective)

34.

Aristotle] was a:
Ptolemy	
Copernicus	
Tycho	
Kepler	
Galileo	
Newton	

- (A) "non-scientist" (explanations based on first principles and assumptions).
(B) "scientist" (explanations based on observations and evidence).
(C) (Both of the above choices.)
(D) (Neither of the above choices.)
(E) (Unsure/guessing/lost/help!)

(Subjective)

35. _____ was courageous in publicizing their work.

- (A) Copernicus.
(B) Galileo.
(C) (Both of the above choices.)
(D) (Neither of the above choices.)
(E) (Unsure/guessing/lost/help!)

(Subjective)

36. _____ was honest in developing a model of planetary motion.

- (A) Copernicus.
(B) Kepler.
(C) (Both of the above choices.)
(D) (Neither of the above choices.)
(E) (Unsure/guessing/lost/help!)