Answers to Practice Questions
Topic 4; Motions of the Earth, Moon, and Sun

Part A

1. (4)
   B-B' represents the equinoxes (3/21 and 9/21 or 9/23) and D-D' represents the summer solstice (6/21). C-C' is the sun's path between dates 3/21 and 6/21 and also 6/21 and 9/21 or 9/23. As a result, May 1 can fit in the range of 3/21 and 6/21, and August 1 can fit in the range of 6/21 and 9/21 or 9/23. Remember, the path of the sun cycles between the lowest solar noon (A-A') and the highest solar noon (D-D').

2. (2)
   If there is 12-hours of darkness there must be 12-hours of daylight, then there is an equal amount for each. If there is an equal amount of daylight and darkness, then it **must** be an equinox. During an equinox, the sun will rise **due east** and set **due west** for any observer. Due east is in the direction of B and due west is in the direction of B'.

3. (1)
   Path A-A' is the shortest path and it also represents 12/21 for an observer in the northern hemisphere. Since an equinox has 12-hours of daylight and the sun's path is definitely shorter on 12/21, then the amount of daylight hours **must** be less than 12-hours. The only choice suitable for path A-A' is 9 hours.

4. (3)
   As a rule, any observer on Earth (excluding the Arctic and Antarctic Circles) would experience sunrise **north of due east, or north of east** and sunset **north of due west, or north of west** on 6/21.

5. (3)
   Celestial bodies such as the sun, moon, and stars rise and set each **day** from New York State because Earth rotates on its axis. If the Earth did not rotate, there will be no apparent rising and setting.

6. (3)
   The Earth rotates on its axis at an angle of 23.5° from the vertical. As the Earth revolves around the sun, the angle between its axis and orbital plane will always remain the same because of **parallelism.**

7. (1)
   Foucault pendulum is evidence of the Earth's rotation. The path of the pendulum will appear to change; however, if Earth did not rotate then it would continue to swing in fixed position A-A'.

8. (3)
   Earth's rate of revolution is 1° per day. Since the angles are equal to 27°, then it had to have taken 27 days for the Earth to travel from A to B.

9. (4)
   For a new moon phase to occur, the alignment must be sun-moon-earth. At location 3 would be the new moon phase. Directly opposite of location 3 is location 1 where we would experience a full moon. Gibbous moons would be between locations 4 and 1 (waxing gibbous) and locations 1 and 3 (waning gibbous). Since the moon is near the new moon phase then it must be in the crescent phase.

10. (2)
    There are several important moon phases: new moon, waxing crescent, first quarter, waxing gibbous, full moon, waning gibbous, third quarter, and waning crescent. It takes 27.3 days for the moon to complete one full revolution around the Earth (pg. 15 ESRT "Solar System Data"). The amount of time it takes to complete the moon phases is slightly longer, 29.5 days. This is due to the moon constantly catching up to the revolving Earth. On average, it takes 3.25 days to complete the moon phases. When the moon is at the crescent at location B, it can take up to 3.25 days to move to the new moon phase found at location A.

11. (3)
    The moon phases lag behind the actual time of its revolution because the moon is constantly catching up to the revolving Earth.

12. (2)
    The highest tides (spring tides) will occur during the new and full moon phases. As a result, the gravitational attraction is at its greatest because the three celestial bodies, sun-Earth-moon are aligned.

13. (4)
    The Coriolis effect is evidence of Earth's rotation. Ocean currents (pg.4 ESRT, "Surface Ocean Currents") and planetary winds (pg. 14 ESRT, "Planetary Wind and Moisture Belts in the Troposphere) are curved because of the Earth's rotation. If the Earth did not rotate, then the ocean currents and planetary winds would travel in straight paths.

14. (4)
    Because of the Coriolis effect, the projectile will curve as it travels across Earth's surface. The projectile and all other materials will curve to the right in the northern hemisphere and to the left in the southern hemisphere. In order to understand this, turn the page upside down so that the projectile is not pointing at you. This way you can see which arrow [choice (3) and choice (4)] curves to the right.

15. (4)
Some stars you can observe during different **seasons.** Notice that the question states the words summer and winter. As a result, observing constellations during different times of the year is evidence of the Earth revolving around the sun.

16. (2)
Venus will never appear motionless or move in a straight line because it revolves around the sun. If an observer on Earth watches the path of Venus, it will appear to change position with respect to the background field of stars behind it.

17. (3)
The diagram of Earth is during an equinox because the daylight/darkness boundary goes through the North Pole. The direction of rotation is labeled on the diagram. If the direction of rotation was not labeled, Earth rotates in a counter-clockwise direction. At point X, 0° latitude, it is moving toward the dark side of Earth. During an equinox, there are 12 hours of daylight and 12 hours of darkness. During sunrise, the time is approximately 6 a.m. and at sunset, the time is approximately 6 p.m.

18. (1)
The moon is tilted 5° from the plane of Earth's orbit around the sun.

Part B

19. (1)
Using the chart on the "Tidal Record for Reversing Falls, St. John's River", there are four changes of tides throughout the course of June 28th. The first high tide was at 4:05 a.m. (just before the 6 a.m. marker on each of the four graphs). The first low tide was at 10:25 a.m. (just before the noon marker). The second high tide was at 4:35 p.m. (just before the 6 p.m. marker). The second low tide was at 10:45 p.m. (just before the midnight marker).

20. 50 seconds
Take the time difference for the first high tides on June 26th (2:25 a.m.) and June 27th (3:15 a.m.).

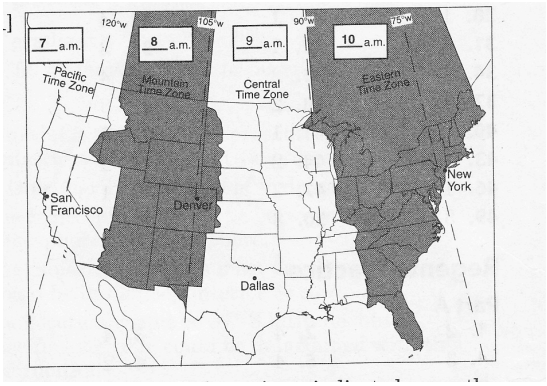
21. (2)
Tides are a great example of something a scientist can predict. There is an approximate 6-hour time difference between each tide change. Also, the change in tides is cyclic. They occur over and over again each day, high tide then low tide, high tide then low tide, etc…

22. …moon is closer to the Earth than the sun is.

23. (1)

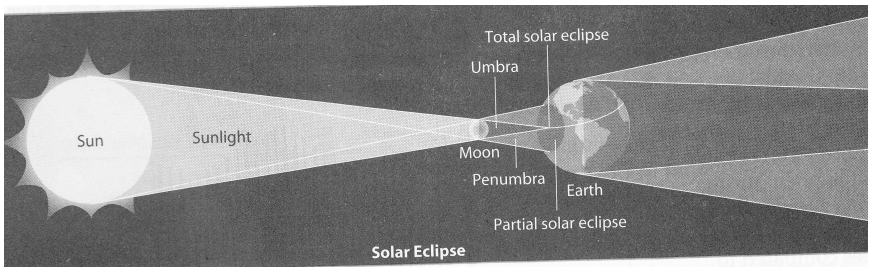
High tides are seen within the Earth's hydrosphere because of the gravitational effect of the sun and moon. They must all be aligned. Think of the alignment as a straight line. Choice (1) has the sun-moon-Earth alignment. The other type of alignment is the sun-Earth-moon.

24.



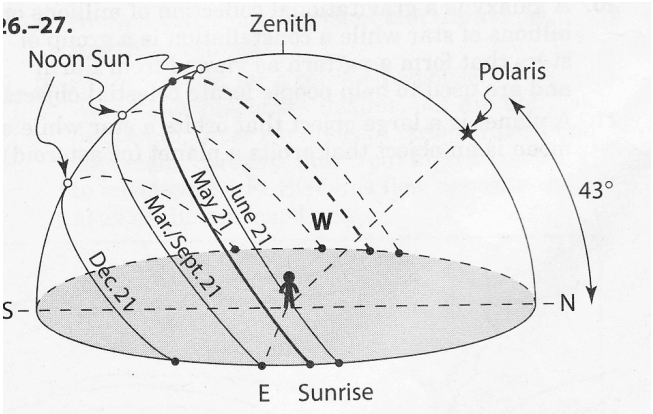
Remember this, the rate of Earth's rotation is 15° per hour. Solar time on Earth is separated by 15° longitude. Notice that the highlighted areas are the boundaries between consecutive time zones.

25.



You must have the following words labeled in your diagram: umbra, penumbra, new moon phase, Earth, and total solar eclipse.

26. & 27.



28. 43°N
    In the diagram, the apparent position of Polaris is labeled as 43°. As a result, only observers from the northern hemisphere can observe Polaris. Also, since Polaris is directly above the axis of rotation, the altitude of Polaris is equal to the observer's line of latitude.

29. 3 p.m. (+/- 1 hour)
    Since the sun is shown past solar noon for March 21st (equinox) we can estimate the time to be 3 p.m. Since there is an equal amount of daylight hours on the equinox, there must be 12-hours of daylight. As a result, from sunrise to noon totals 6 hours (6 a.m. to noon) and from noon to sunset totals the remaining 6 hours (noon to 6 p.m.). Since the sun is in the middle from noon to sunset, it must be 3 p.m.

Part C

30. Earth would still have tides because of the gravitational pull of the sun.

31. The ocean tides would be much lower at high tide and still lower at low tide without the moon and the timing of the tides would be slightly different.

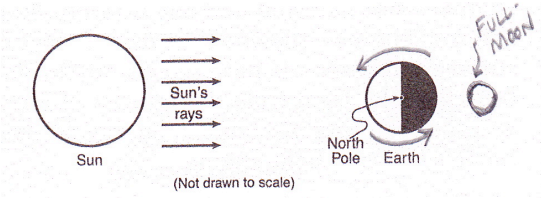
32. Since the moon is involved in the production of both lunar and solar eclipses, if there were no moon, neither type of eclipse would occur.

33. Timekeeping would have been affected by the lack of moon because early people kept time by the moon. Without the moon there would be no concept of the month, and the year would have to be divided into different units.

34. Earth's day would be most altered.

35. The apparent motions of celestial objects in the sky would not exist without Earth's rotation. Also the Coriolis effect and the apparent motions of the Foucault pendulum would not exist without Earth's rotation.

36. a) and b)

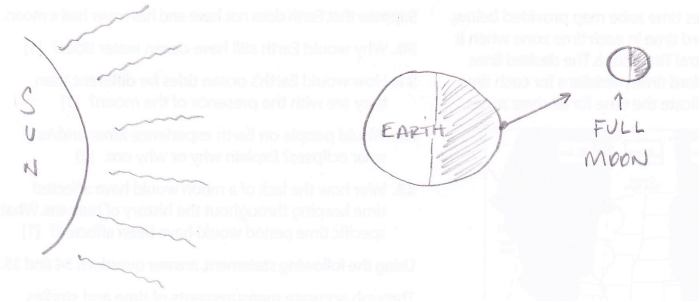


37. An asteroid, meteorite, meteor, or comet could have caused the impact crater at Diablo Canyon, Arizona.

38. A blue moon would never occur in February because it has 28 or 29 days and the cycle of moon phases takes 29.5 days.

39. The greatest number of full moon phases is a span of a single year is 12.

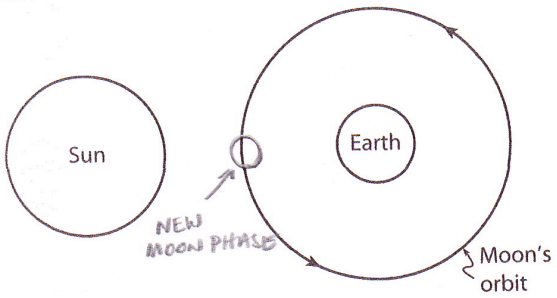
40.



41. The time of sunrise changed for the observer each day during the month of May because we were heading into the summer solstice. The summer solstice occurs when the northern hemisphere is pointing toward the sun, As a result, we experience the longest day of the year and the most intense insolation. The time of sunrise each day would have been earlier and earlier each day in May.

42. Rotation

43.



44. The moon makes one complete revolution each month.
Think of a single "moonth"

45. Solar eclipses do not occur every time the moon is at the new moon phase because the moon is tilted 5° from the plane of Earth's orbit.

46. Mercury
Consult pg. 15 of the ESRT, "Solar System Data".

47. Galileo's observations of Jupiter's four moons did not support the geocentric model because the moons would disappear when they orbited Jupiter. In addition, when viewing these moons from Earth, the moons may appear to form epicycles.