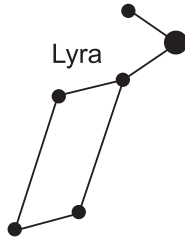


SPACE SCIENCE

- Evidence that the universe is expanding is best provided by the
 - red shift in the light from distant galaxies
 - change in the swing direction of a Foucault pendulum on Earth
 - parallelism of Earth's axis in orbit
 - spiral shape of the Milky Way Galaxy
- In Northern hemisphere, summer is warmer than winter because in summer Northern hemisphere has
 - fewer hours of daylight and receives low angle insolation
 - fewer hours of daylight and receives high angle insolation
 - more hours of daylight and receives low-angle insolation
 - more hours of daylight and receives high angle insolation
- Which object forms by the contraction of a large sphere of gases causing the nuclear fusion of lighter elements into heavier elements?
 - comet
 - star
 - planet
 - moon
- Which statement best describes the position of the Sun at sunrise and sunset as seen by an observer in Northern hemisphere on June 21?
 - The Sun rises north of due east and sets north of due west.
 - The Sun rises south of due east and sets south of due west.
 - The Sun rises north of due east and sets south of due west.
 - None of these
- Which statement best describes the age of our solar system and the universe?
 - The universe is at least twice as old as our solar system.
 - Our solar system is at least twice as old as the universe.
 - Our solar system and the universe are estimated to be 5 billion years old.
 - Our solar system and the universe are estimated to be 10 billion years old.
- A Foucault pendulum is used to prove that
 - The Sun rotates on its axis
 - The Sun revolves around Earth
 - Earth rotates on its axis
 - Earth revolves around the Sun
- What is the approximate rate of Earth's revolution around the Sun?
 - 1° per day
 - 10° per day
 - 5° per year
 - 15° per year
- Which event is caused by Earth's revolution?
 - The apparent shift in the path of a Foucault pendulum
 - deflection of planetary winds to the right in the Northern Hemisphere
 - the apparent rising and setting of the Sun
 - different constellations observed in the night sky throughout the year
- As viewed from Earth, most stars appear to move across the sky each night because
 - Earth revolves around the Sun
 - Earth rotates on its axis
 - Stars orbit around Earth
 - Stars revolve around the center of the galaxy
- The explosion associated with the Big Bang theory and the formation of the universe is inferred to have occurred how many billion years ago?
 - less than 1
 - 4.6
 - 2.5
 - over 10

The diagram below represents the constellation Lyra.



11. Which statement best explains why Lyra is visible to an observer in Northern hemisphere at midnight in July but not visible at midnight in December?

- (1) Earth spins on its axis.
- (2) Earth orbits the Sun.
- (3) Lyra spins on its axis.
- (4) Lyra orbits Earth.

12. The star *Algol* is estimated to have approximately the same luminosity as the star *Aldebaran* and approximately the same temperature as the star *Rigel*. *Algol* is best classified as a

- (1) main sequence star (2) red giant star
- (3) white dwarf star (4) red dwarf star

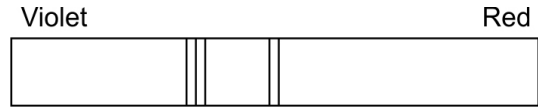
13. The best evidence that Earth spins on its axis is the motion of

- (1) tectonic plates
- (2) *Polaris*
- (3) a wind vane
- (4) a Foucault pendulum

14. When viewed from Earth, the light from very distant galaxies shows a red shift. This is evidence that these distant galaxies are

- (1) revolving around the Sun
- (2) revolving around the Milky Way
- (3) moving away from Earth
- (4) moving toward Earth

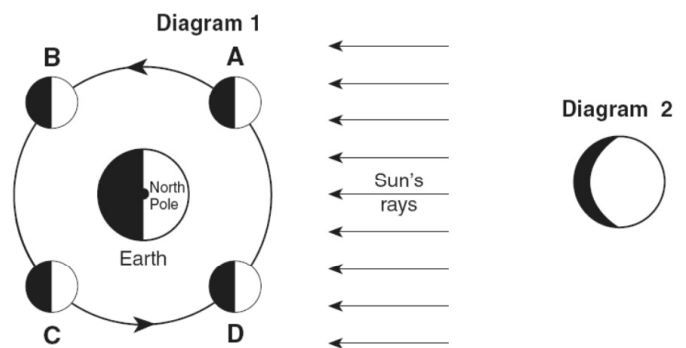
The diagram below shows the spectral lines for an element.



15. Which diagram best represents the spectral lines of this element when its light is observed coming from a star that is moving away from Earth?

- (1) Violet Red
- (2) Violet Red
- (3) Violet Red
- (4) Violet Red

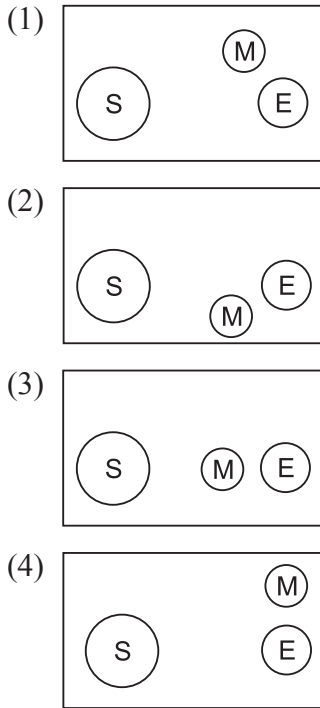
Direction: Diagram 1 shows the Moon in its orbit at four positions labeled A, B, C, and D. Diagram 2 shows a phase of the Moon as viewed from Northern hemisphere.



16. At which labeled Moon position would the phase of the Moon shown in diagram 2 be observed from Northern hemisphere?

- (1) A
- (2) B
- (3) C
- (4) D

17. Which arrangement of the Sun, the Moon, and Earth results in the highest high tides, and the lowest low tides on Earth?



Base your answers to Questions 18 through 21 on the passage and diagram below. The diagram shows the orbits of the four inner planets and the asteroid Hermes around the Sun. Point A represents a position along Hermes' orbit.

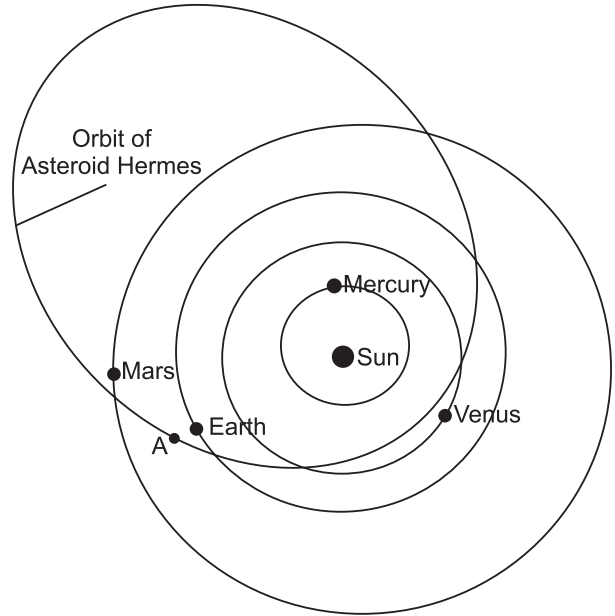
The Curious Tale of Asteroid Hermes

It's dogma [accepted belief] now: an asteroid hit Earth 65 million years ago and wiped out the dinosaurs. But in 1980 when scientists Walter and Luis Alvarez first suggested the idea to a gathering at the American Association for Advancement of Sciences, their listeners were skeptical. Asteroids hitting Earth? Wiping out species? It seemed incredible. At that very moment, unknown to the audience, an asteroid named Hermes halfway between Mars and Jupiter was beginning a long plunge toward our planet. Six months later it would pass 300,000 miles from Earth's orbit, only a little more than the distance to the Moon....

Hermes approaches Earth's orbit twice every 777 days. Usually our planet is far away when the orbit crossing happens, but in 1937, 1942, 1954, 1974 and 1986, Hermes came harrowingly [dangerously] close to Earth itself. We know about most of these encounters only because Lowell

Observatory astronomer Brian Skiff rediscovered Hermes on Oct. 15, 2003. Astronomers around the world have been tracking it carefully ever since....

Excerpted from "The Curious Tale of Asteroid Hermes," Dr. Tony Phillips, Science @ NASA, November 3, 2003



18. When Hermes is located at position A and Earth is in the position shown in the diagram, the asteroid can be viewed from Earth at each of the following times except

- (1) sunrise
- (2) sunset
- (3) 12 noon
- (4) 12 midnight

19. How does the period of revolution of Hermes compare to the period of revolution of the planets shown in the diagram?

- (1) Hermes has a longer period of revolution than Mercury, but a shorter period of revolution than Venus, Earth, and Mars.
- (2) Hermes has a shorter period of revolution than Mercury, but a longer period of revolution than Venus, Earth, and Mars.
- (3) Hermes has a longer period of revolution than all of the planets shown.
- (4) Hermes has a shorter period of revolution than all of the planets shown.

20. Why is evidence of asteroids striking Earth so difficult to find?

- (1) Asteroids are made mostly of frozen water and gases and are vaporized on impact.
- (2) Asteroids are not large enough to leave impact craters.
- (3) Asteroids do not travel fast enough to create impact craters.
- (4) Weathering, erosion, and deposition on Earth have destroyed or buried most impact craters.

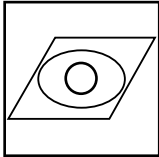
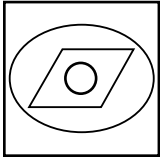
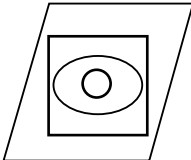
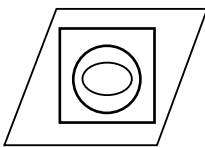
21. According to the diagram, as Hermes and the planets revolve around the Sun, Hermes appears to be a threat to collide with

- (1) Earth, only
- (2) Earth and Mars, only
- (3) Venus, Earth, and Mars, only
- (4) Mercury, Venus, Earth, and Mars

The symbols below are used to represent different regions of space.

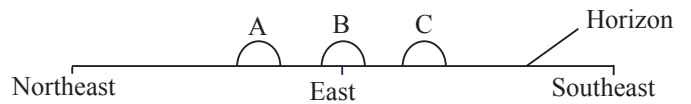
Universe = □ Earth = ○ Galaxy = ▭
Solar system = ○

22. Which diagram shows the correct relationship between these four regions? [If one symbol is within another symbol, that means it is part of, or included in, that symbol.]

- (1) 
- (2) 
- (3) 
- (4) 

Direction: A student in Northern hemisphere looked toward the eastern horizon to observe sunrise at three different times during the year. The student drew the

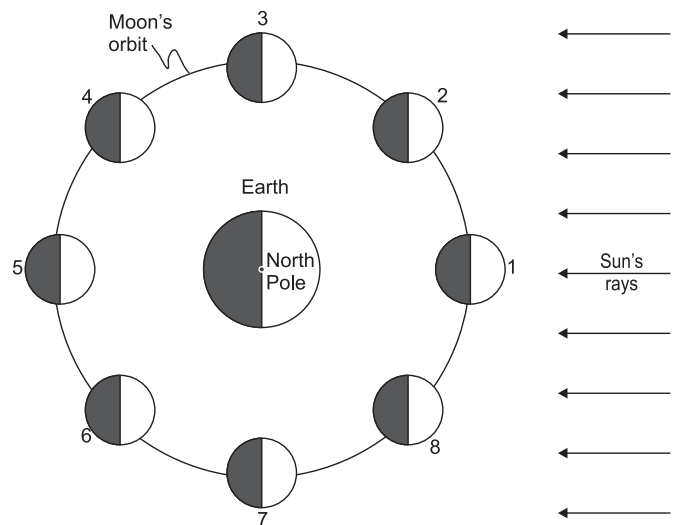
following diagram that shows the positions of sunrise, A, B, and C, during this one-year period.



23. Which list correctly pairs the location of sunrise to the time of the year?

- (1) A—June 21 B—March 21 C—December 21
- (2) A—December 21 B—March 21 C—June 21
- (3) A—March 21 B—June 21 C—December 21
- (4) A—June 21 B—December 21 C—March 21

Direction: The diagram below shows the Moon orbiting Earth, as viewed from space above Earth's North Pole. The Moon is shown at eight positions in its orbit.



Spring ocean tides occur when the difference in height between high tide and low tide is greatest.

24. At which two positions of the Moon will spring tides occur on Earth?

- (1) 1 and 5
- (2) 2 and 6
- (3) 3 and 7
- (4) 4 and 8

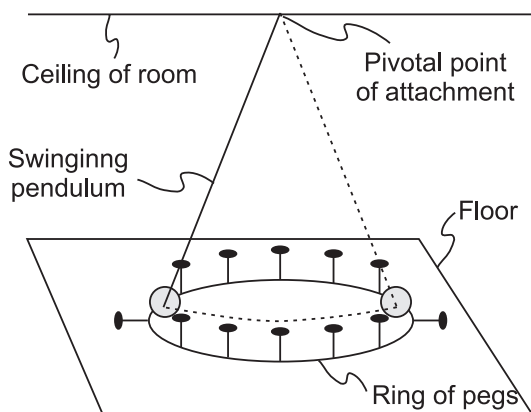
25. Which sequence correctly lists the relative sizes from smallest to largest?

- (1) Our solar system, universe, Milky Way Galaxy
- (2) Our solar system, Milky Way Galaxy, universe
- (3) Milky Way Galaxy, our solar system, universe
- (4) Milky Way Galaxy, universe, our solar system

26. Compared to other groups of stars, the group that has relatively low luminosities and relatively low temperatures is the

- (1) White Dwarfs
- (2) Red Dwarfs
- (3) Red Giants
- (4) Blue Supergiants

Direction: The diagram below represents a swinging Foucault pendulum.



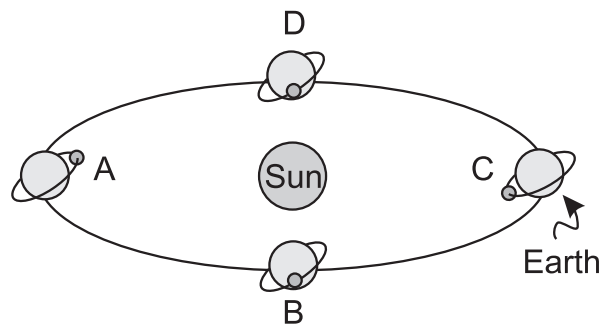
27. This pendulum will show an apparent change in the direction of its swing due to Earth's

- (1) curved surface
- (2) tilted axis
- (3) rotation
- (4) revolution

28. Which list of three planets and Earth's Moon is arranged in order of increasing equatorial diameter?

- (1) Earth's Moon, Pluto, Mars, Mercury
- (2) Pluto, Earth's Moon, Mercury, Mars
- (3) Mercury, Mars, Earth's Moon, Pluto
- (4) Mars, Mercury, Pluto, Earth's Moon

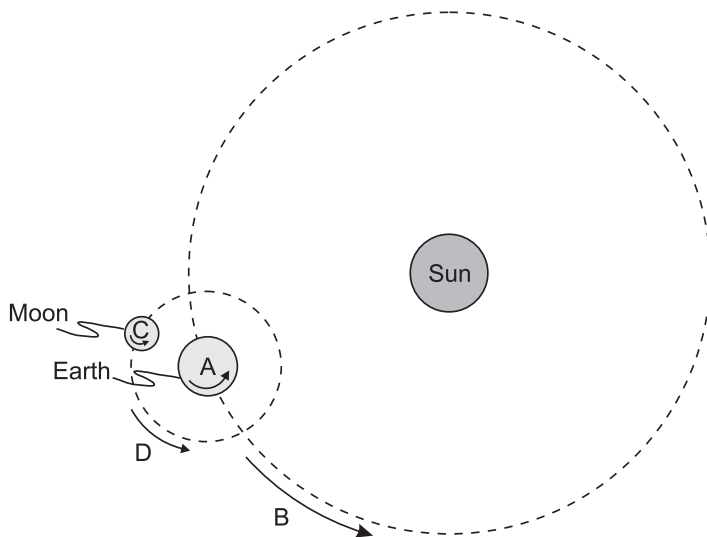
Direction: The diagram below shows Earth's orbit around the Sun and different positions of the Moon as it travels around Earth. Letters A through D represent four different positions of the Moon.



29. An eclipse of the Moon is most likely to occur when the Moon is at position

- (1) A
- (2) B
- (3) C
- (4) D

Direction: Base your answers to Q. 30 through Q. 32 on the diagram below, which has lettered arrows showing the motions of Earth and the Moon.



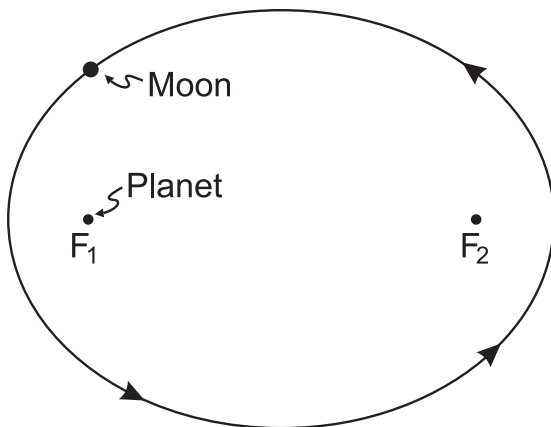
Key	
Arrow	Motion
A	Earth's rotation on its axis
B	Earth's revolution around the Sun
C	The Moon's rotation on its axis
D	The Moon's revolution around Earth

30. These lettered arrows represent motions that are

- (1) noncyclic and unpredictable
- (2) noncyclic and predictable
- (3) cyclic and unpredictable
- (4) cyclic and predictable

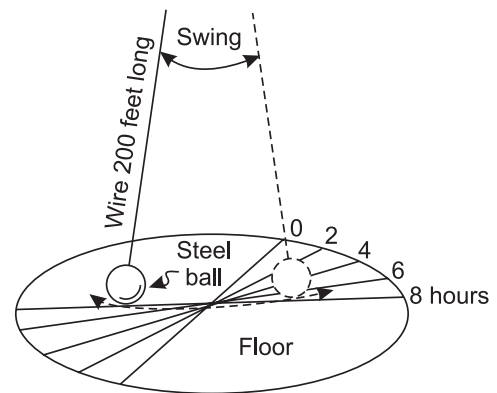
31. Which two motions are completed in about the same amount of time?
- (1) A and B
 - (2) B and C
 - (3) C and D
 - (4) A and D
32. Which lettered arrow represents the motion that causes the Moon to show phases when viewed from Earth?
- (1) A
 - (2) B
 - (3) C
 - (4) D
33. Which star has a higher luminosity and a lower temperature than the Sun?
- (1) Rigel
 - (2) Barnard's Star
 - (3) Alpha Centauri
 - (4) Aldebaran
34. Starlight from distant galaxies provides evidence that the universe is expanding because this starlight shows a shift in wavelength toward the
- (1) red-light end of the visible spectrum
 - (2) blue-light end of the visible spectrum
 - (3) ultraviolet-ray end of the electromagnetic spectrum
 - (4) gamma-rays

Direction: The diagram below represents the elliptical orbit of a moon revolving around a planet. The foci of this orbit are the points labeled F_1 and F_2 .



(Drawn to Scale)

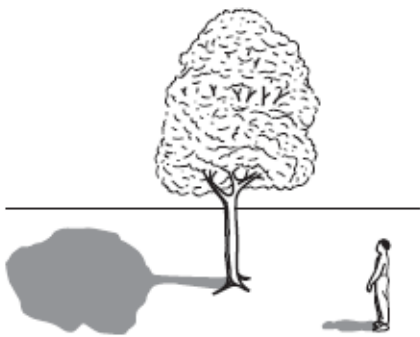
35. What is the approximate eccentricity of this elliptical orbit?
- (1) 0.3
 - (2) 0.5
 - (3) 0.7
 - (4) 1.4
36. If Earth's axis were tilted 35° instead of 23.5° , the average temperatures in Northern hemisphere would most likely
- (1) decrease in both summer and winter
 - (2) decrease in summer and increase in winter
 - (3) increase in summer and decrease in winter
 - (4) increase in both summer and winter
37. On which day of the year would the intensity of insolation at a city located in northern hemisphere most likely be greatest?
- (1) March 21
 - (2) June 21
 - (3) September 23
 - (4) None of these
38. The diagram below represents a Foucault pendulum swinging freely for 8 hours.



The Foucault pendulum appears to gradually change its direction of swing due to Earth's

- (1) orbit around the Sun
- (2) curved surface
- (3) tilted axis
- (4) spin on its axis

Direction: The diagram below shows the noontime shadows cast by a student and a tree.



39. If the time is solar noon and the student is located way up in Northern hemisphere, in what direction is the student facing?

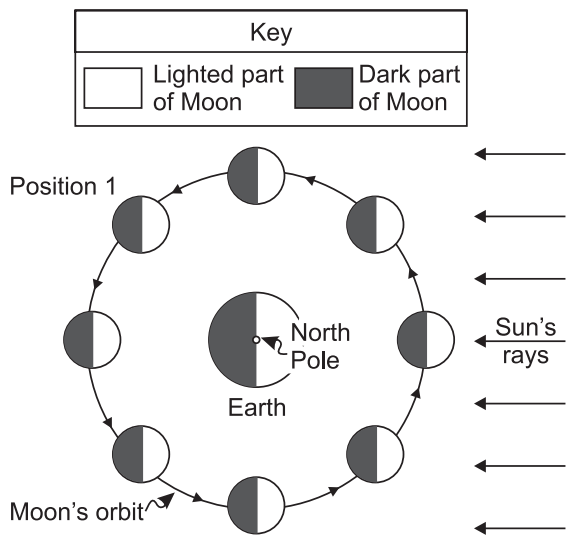
- (1) north
- (2) south
- (3) east
- (4) west

40. During nighttime cooling, most of the energy radiated by Earth's oceans into space is

- (1) ultraviolet rays
- (2) gamma rays
- (3) visible light rays
- (4) infrared rays

INTERACTIVE SECTION

Direction: The diagram below represents the Moon in its orbit, as viewed from above Earth's North Pole. Position 1 represents a specific location of the Moon in its orbit.

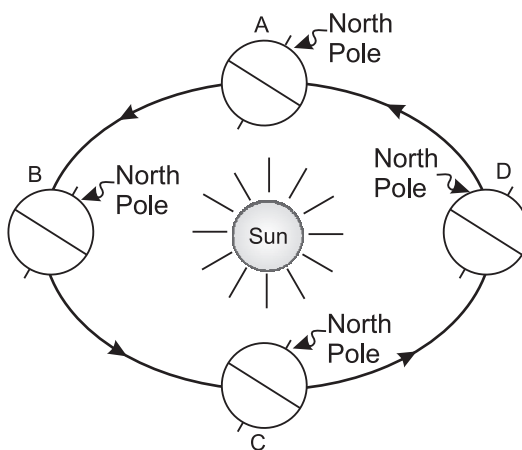


41. Which phase of the Moon will be seen from Earth when the Moon is at position 1?

- (1)
- (2)
- (3)
- (4)

Direction: Base your answers to questions 42 through 44 on the diagram below, which represents an exaggerated view of Earth revolving around the Sun. Letters A, B, C,

and D represent Earth's location in its orbit on the first day of each of the four seasons.



42. Which location in Earth's orbit represents the first day of autumn for an observer in Northern hemisphere?

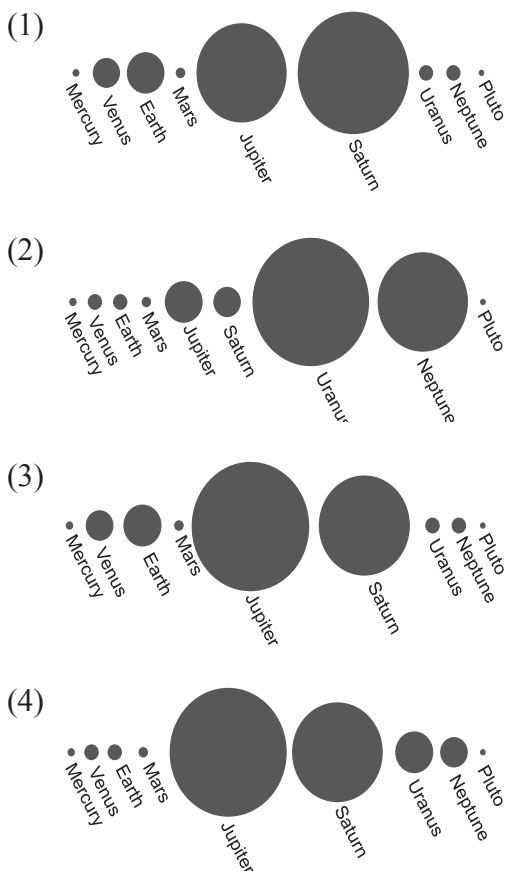
- (1) A
- (2) B
- (3) C
- (4) D

43. Earth's rate of revolution around the Sun is approximately

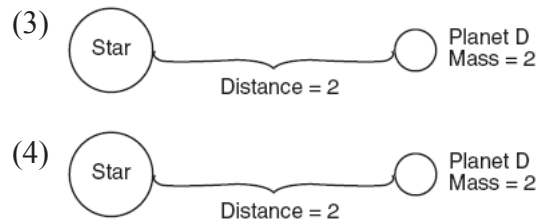
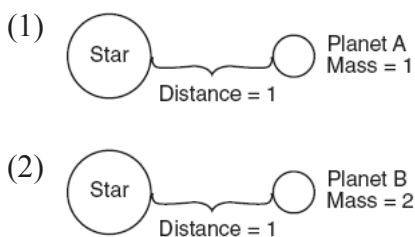
- (1) 1° per day
- (2) 360° per day
- (3) 15° per hour
- (4) 23.5° per hour

44. Which observation provides the best evidence that Earth revolves around the Sun?
- (1) Stars seen from Earth appear to circle Polaris.
 - (2) Earth's planetary winds are deflected by the Coriolis effect.
 - (3) The change from high ocean tide to low ocean tide is a repeating pattern.
 - (4) Different star constellations are seen from Earth at different times of the year.

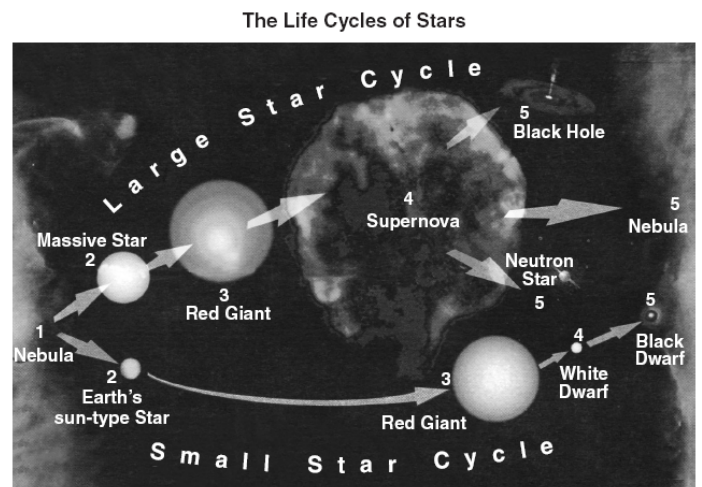
45. Which sequence correctly shows the relative size of the nine planets of our solar system?



46. In each diagram below, the mass of the star is the same. In which diagram is the force of gravity greatest between the star and the planet shown?



Direction: Base your answers to questions 47 through 50 on the diagram below, which shows two possible sequences in the life cycle of stars, beginning with their formation from nebular gas clouds in space.



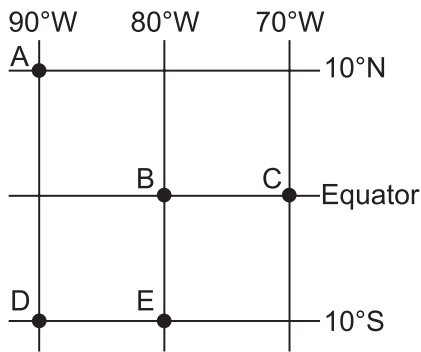
47. According to the diagram, the life-cycle path followed by a star is determined by the star's initial
- (1) mass and size
 - (2) temperature and origin
 - (3) luminosity and color
 - (4) luminosity and structure
48. Stars like Earth's Sun most likely formed directly from a
- (1) nebula
 - (2) supernova
 - (3) red giant
 - (4) black dwarf
49. According to the diagram, a star like Earth's Sun will eventually
- (1) explode in a supernova
 - (2) become a black hole

- (3) change into a white dwarf
- (4) become a neutron star

50. The redshift of light from distant galaxies provides evidence that the universe is

- (1) shrinking, only
- (2) expanding, only
- (3) shrinking and expanding in a cyclic pattern
- (4) remaining the same size

Direction: Base your answers to **questions 51 and 52** on the map below, which shows the latitude and longitude of five observers, A, B, C, D, and E, on Earth.



51. What is the altitude of Polaris (the North Star) above the northern horizon for observer A?

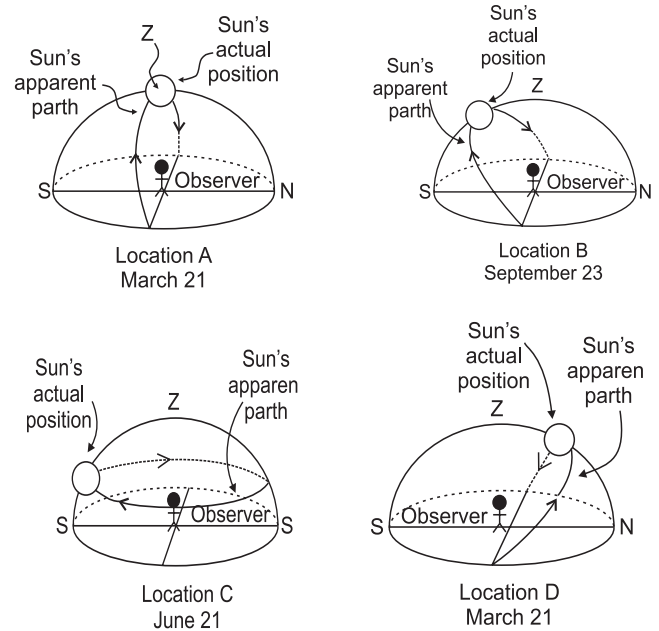
- (1) 0°
- (2) 10°
- (3) 80°
- (4) 90°

52. Which two observers would be experiencing the same apparent solar time?

- (1) A and C
- (2) B and C
- (3) B and E
- (4) D and E

Direction: Base your answers to **questions 53 through 55** on the diagram below, which shows a model of the apparent path and position of the Sun in relation to an observer at four different locations, A, B, C, and D, on

Earth's surface on the dates indicated. The zenith (z) and the actual position of the Sun in the model at the time of the observation are shown. [The zenith is the point directly over the observer.]



53. According to the Sun's actual position shown in the diagrams, the most intense insolation is being received by the observer at location

- (1) A
- (2) B
- (3) C
- (4) D

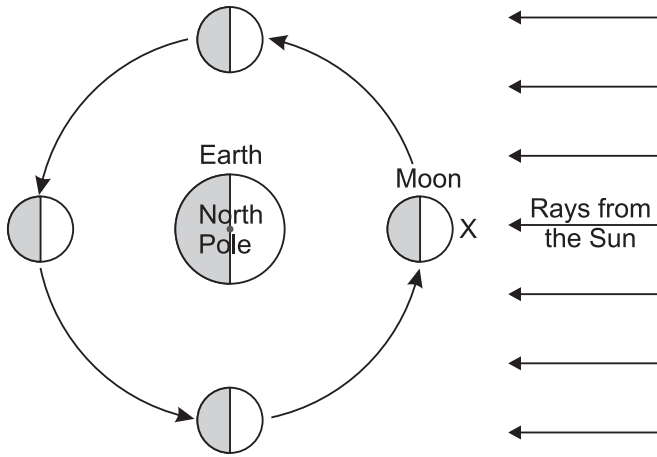
54. Where on Earth's surface is the observer at location C located?

- (1) at the Equator
- (2) at the South Pole
- (3) at the North Pole
- (4) None of these

55. From sunrise to sunset at location B, the length of the observer's shadow will

- (1) increase, only
- (2) decrease, only
- (3) increase, then decrease
- (4) decrease, then increase

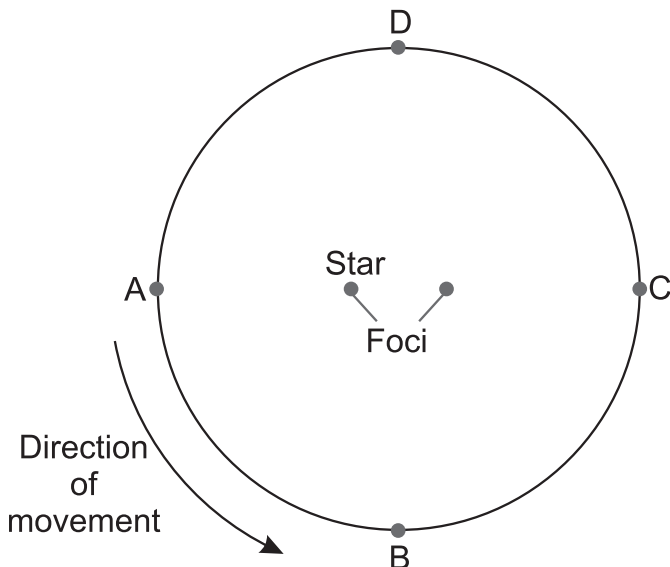
Direction: The diagram below shows the Moon at four positions in its orbit around Earth as viewed from above the North Pole.



56. Beginning with the Moon at position X (the new-Moon phase), which sequence of Moon phases would be seen by an observer on Earth during 1 month?

- (1) → → → →
- (2) → → → →
- (3) → → → →
- (4) → → → →

Direction: Base your answers to questions 57 through 59 on the diagram below, which represents the elliptical orbit of a planet traveling around a star. Points A, B, C, and D are four positions of this planet in its orbit.



57. The calculated eccentricity of this orbit is approximately

- (1) 0.1
- (2) 0.2
- (3) 0.3
- (4) 0.4

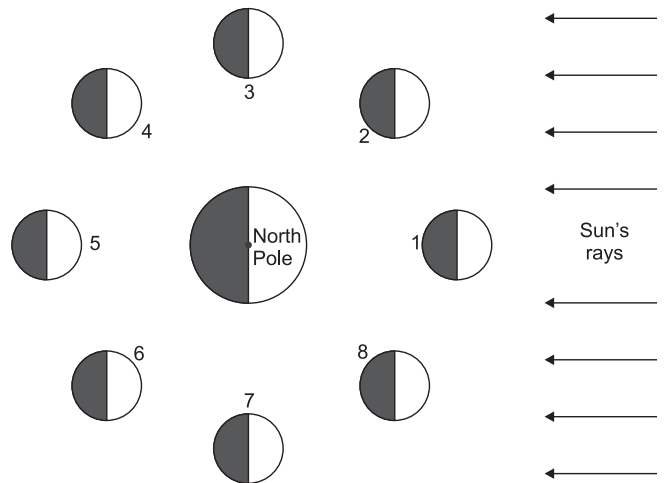
58. The gravitational attraction between the star and the planet will be greatest at position

- (1) A
- (2) B
- (3) C
- (4) D

59. As the planet revolves in orbit from position A to position D, the orbital velocity will

- (1) continually decrease
- (2) continually increase
- (3) decrease, then increase
- (4) increase, then decrease

The diagram below shows the Moon in different positions as it revolves around Earth, as observed from above the North Pole (NP).



60. Which image correctly represents the Moon at position 8, as observed from Earth?

- (1)
- (2)
- (3)
- (4)



END OF THE EXAM