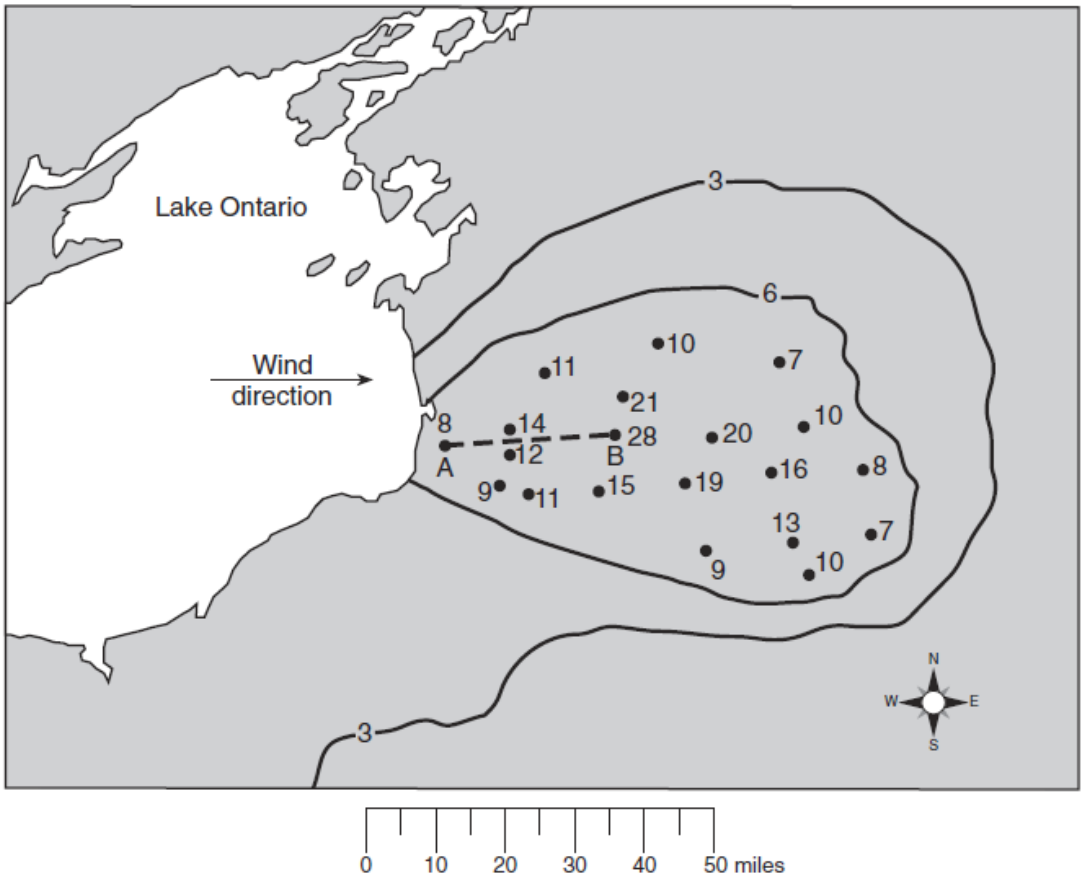
Base your answers to questions **1** and **2** on the snowfall map of the Tug Hill Plateau region of New York State and your knowledge of Earth science. A lake-effect snowstorm occurred on November 16-19, 2008. Snow depths are indicated in inches at several points and by two labeled isoline. Dashed line *AB* is a reference line on the map between two recorded snow depths.

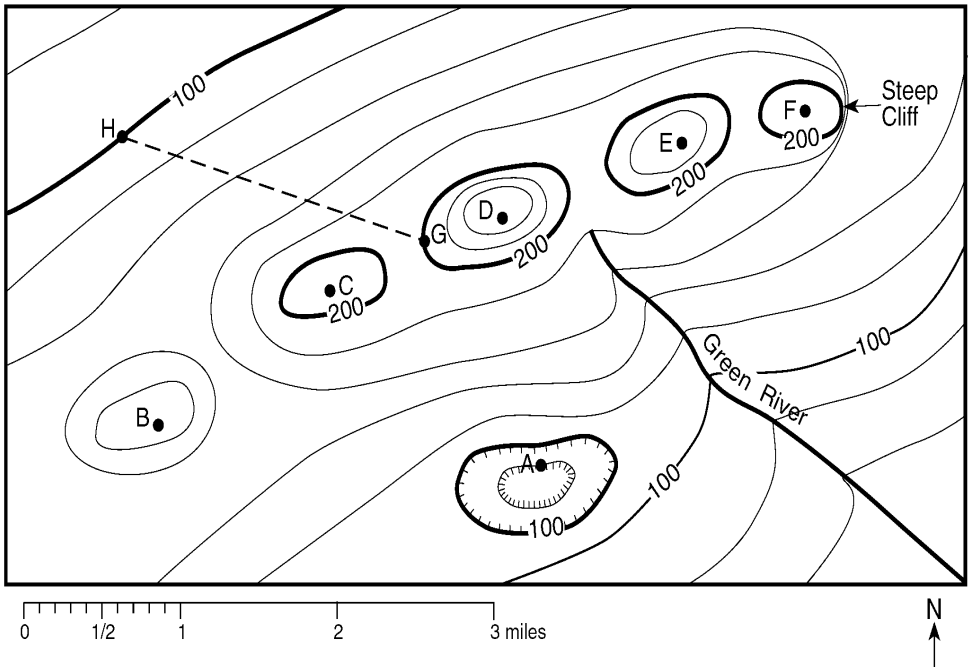
November 16–19, 2008, Storm Snow Depth (inches)



1. Calculate the snow depth gradient between point *A* and point *B*, in inches per mile.

2. On the map, draw the 9-inch and 12-inch snow depth isolines.

Base your answers to questions **3** and **4** on the contour map below. Letters *A* through *H* represent locations in the area represented by the map. Contour lines are labeled in feet.

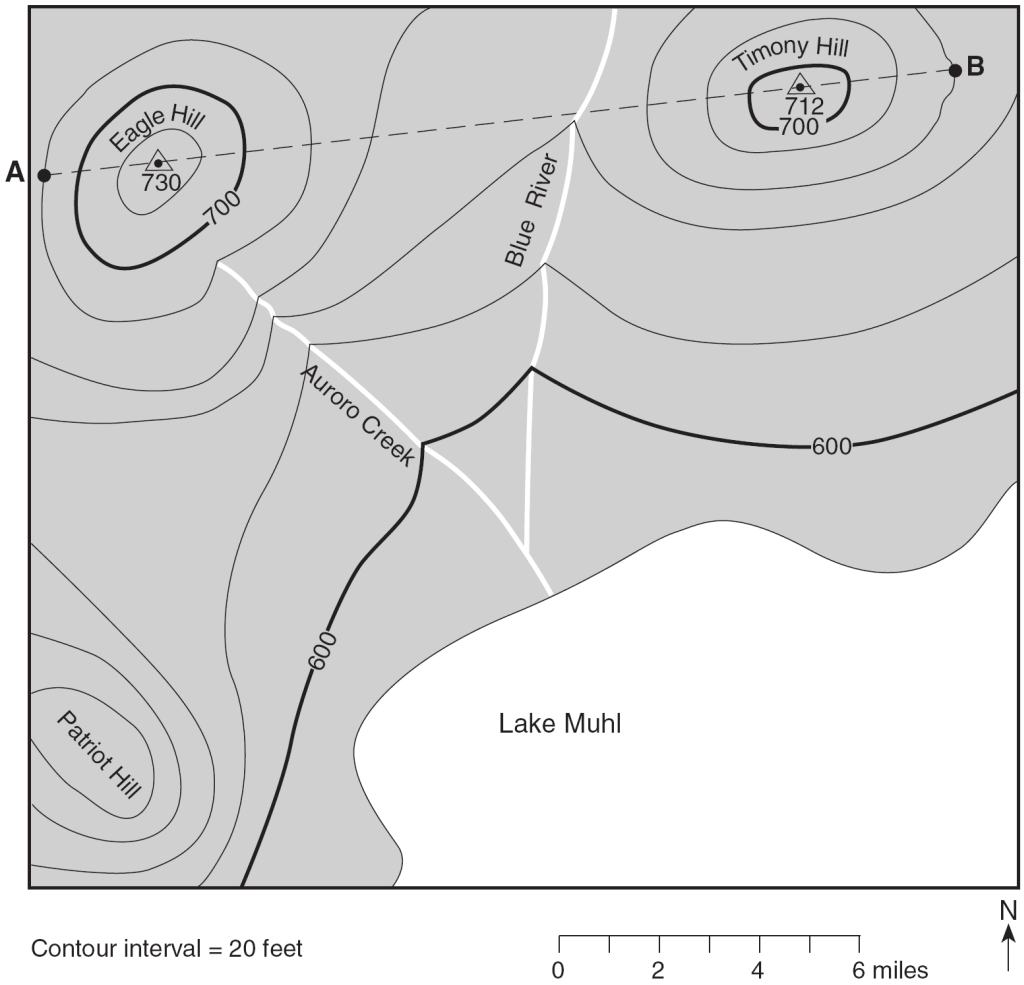


3. Explain how the contour lines on the map indicate that the location labeled "Steep Cliff" is accurately named.

4. Which letter represents the highest elevation?

Base your answers to questions **5** through **7** on the topographic map below. Points *A* and *B* are reference points on the map. The Δ symbols show the highest elevations on Eagle Hill and Timony Hill. Elevations are shown in feet.

Topographic Map



5. On the grid below, construct a topographic profile along line *AB* by plotting an **X** for the elevation of each contour line that crosses line *AB*. Connect the plotted **X**s with a smooth, curved line to complete the profile. Points *A* and *B* have been plotted.

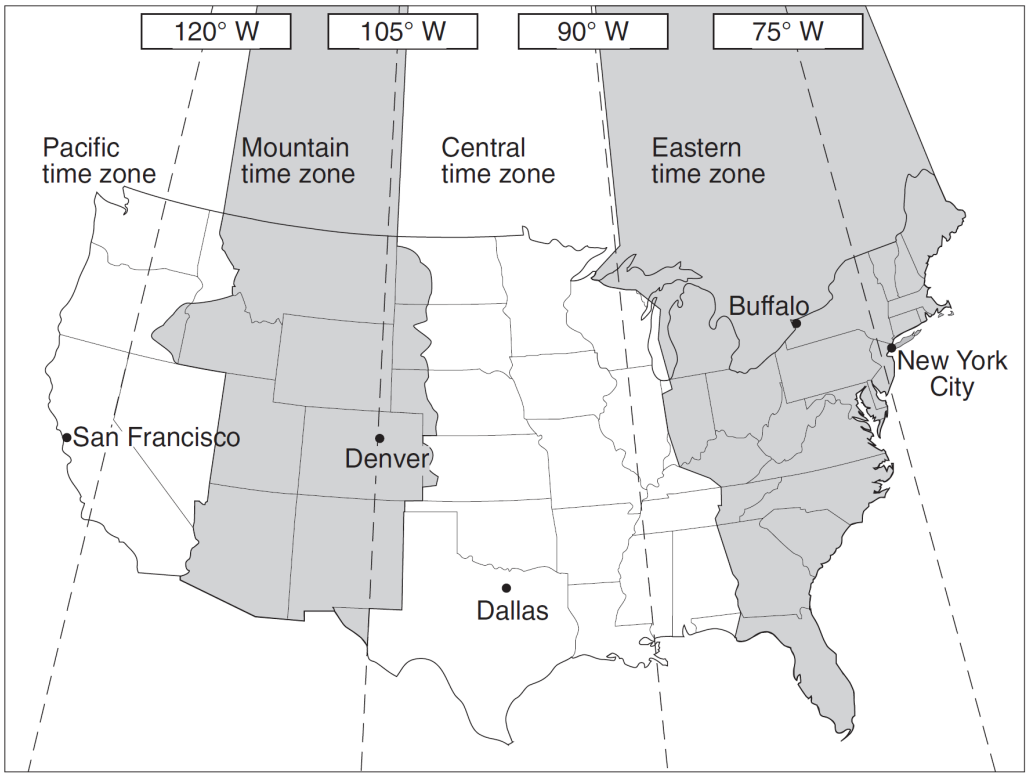
6. State a possible elevation of the top of Patriot Hill.

7. Identify the general compass direction toward which Auroro Creek is flowing.

8. Base your answer to the following question on passage and time zones map shown below.

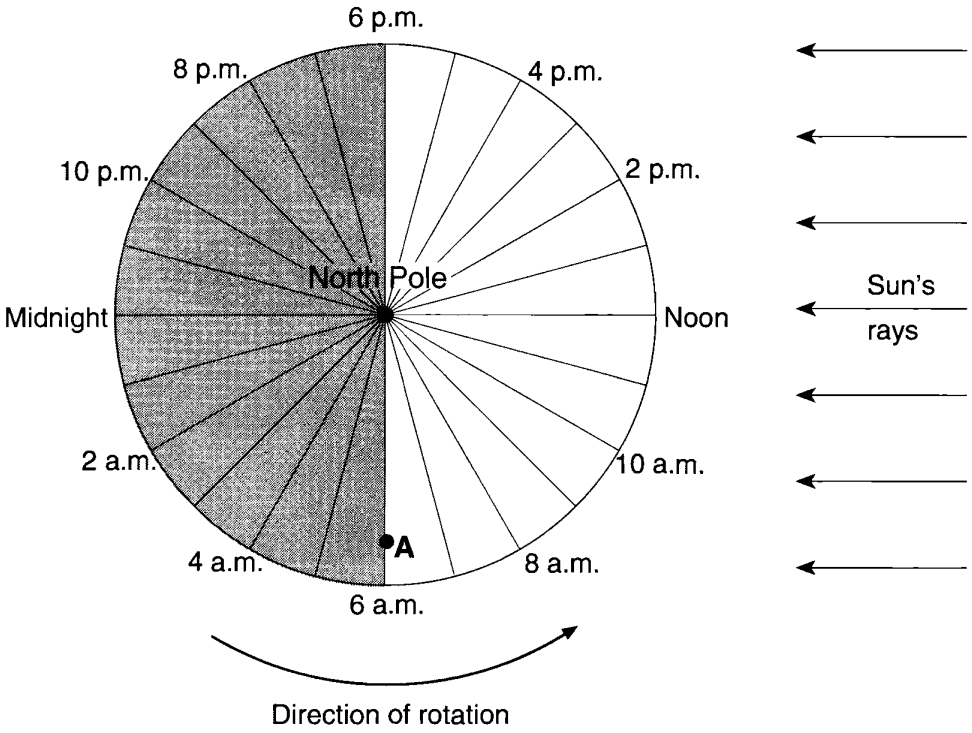
Time Zones

In 1883, Earth was divided into 24 time zones. The United States (excluding Alaska and Hawaii) has four time zones, which are indicated by different shadings on the map.Each zone is roughly centered on lines of longitude that are 15° apart. These lines are shown as dashed lines on the map. Most locations within a time zone have the same time.This time is called standard time. As you move to the west, the time in each zone is one hour earlier than the previous time zone



Explain, in terms of Earth's rotation, why the time zones are 15° of longitude apart.

Base your answers to questions **9** through **11** on the diagram below, which represents a north polar view of Earth on a specific day of the year. Solar times at selected longitude lines are shown. Letter *A* represents a location on Earth's surface.



9. How many hours of daylight would an observer at location *A* experience on this day?

10. State the altitude of *Polaris* as seen by an observer at the North Pole.

11. How many degrees apart are the longitude lines shown in the diagram?

Base your answers to questions **12** through **14** on the data table below, which shows the length of a shadow, in centimeters, made by an object at different times during the day in New York State.

Shadow Lengths

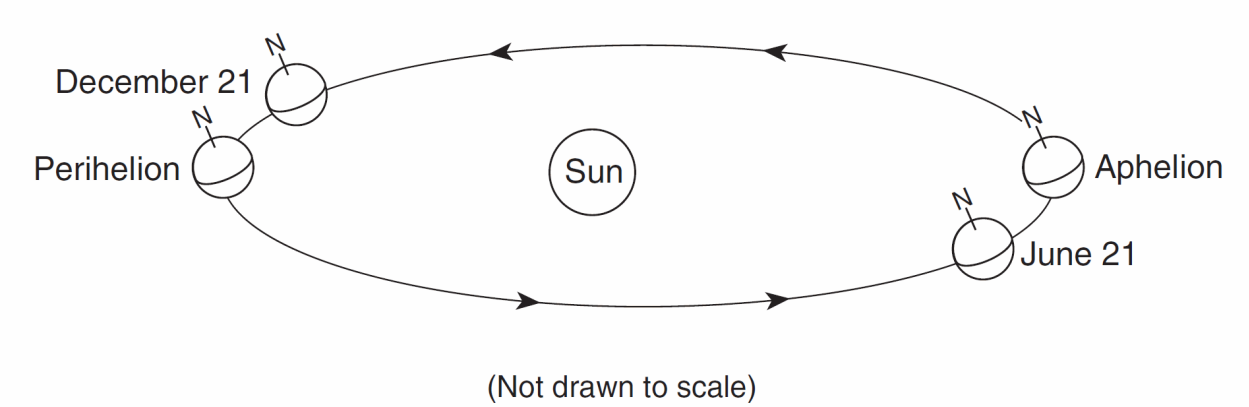
Time	**Length of Shadow** (cm)
9 : 00 a.m.	185
10 : 00 a.m.	129
11 : 00 a.m.	100
12 : 00 noon	89
1 : 00 p.m.	101
2 : 00pm	124

12. Toward which compass direction from the object does the shadow point at solar noon?

13. Explain what causes the length of the shadow to change during the day.

14. Predict the length of the object's shadow at 2:30 p.m.

Base your answers to questions **15** and **16** on the diagram below, which represents an exaggerated model of the shape of Earth's orbit, and on your knowledge of Earth science. The positions of Earth in its orbit on December 21 and June 21 are indicated. The positions of perihelion (when Earth is closest to the Sun) and aphelion (when Earth is farthest from the Sun) are also indicated. Both perihelion and aphelion occur approximately two weeks after the dates shown.

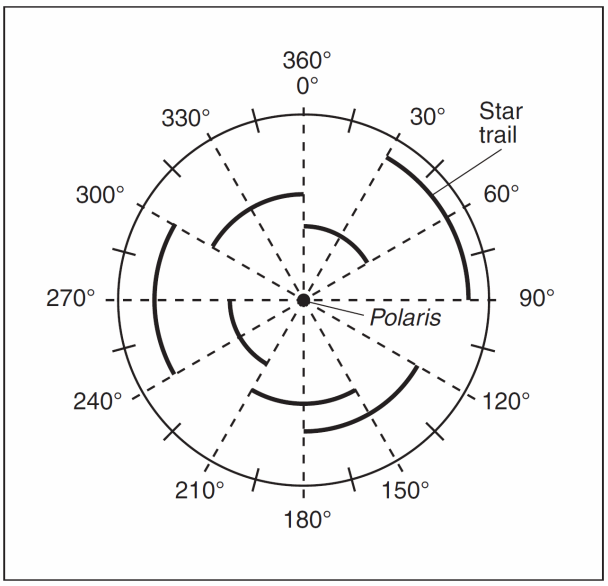


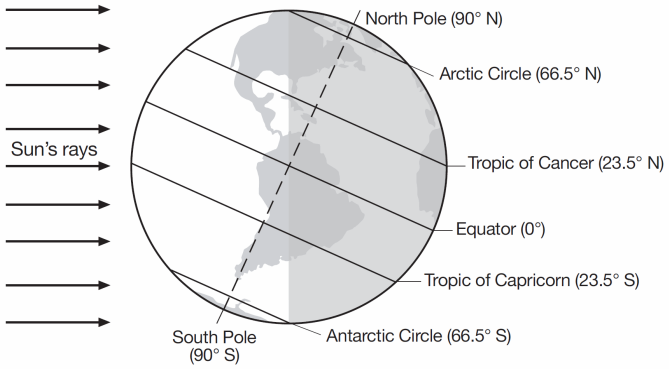
(Not drawn to scale)

15. Explain why warm summer temperatures occur in New York State when Earth is at aphelion.

16. How many months after Earth's perihelion position does Earth's aphelion position occur?

Base your answers to questions **17** through **20** on the diagram below and on your knowledge of Earth science. The diagram represents a time-exposure photograph taken by aiming a camera at *Polaris* in the night sky and leaving the shutter open for a period of time to record star trails. The angular arcs (star trails) show the apparent motions of some stars.





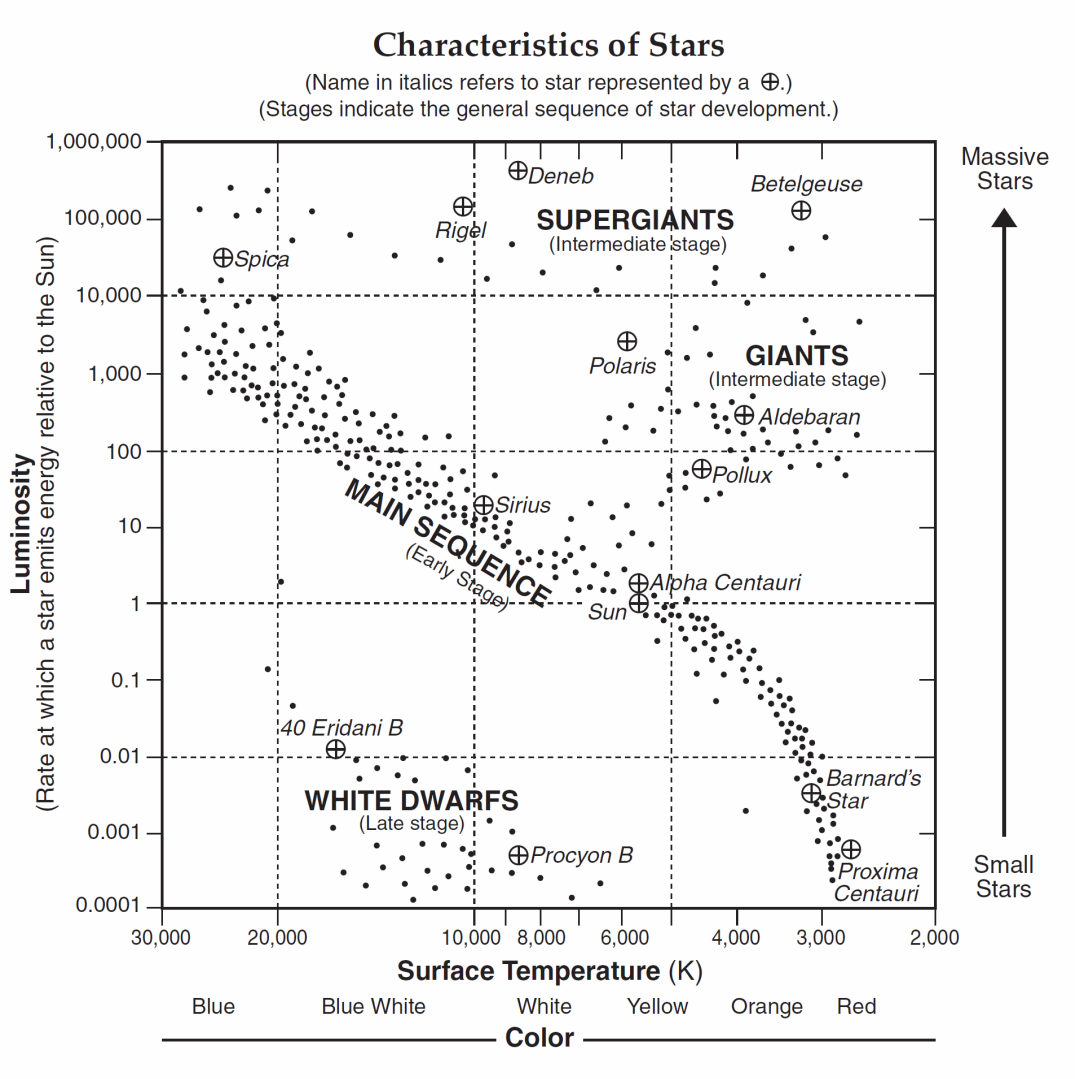
17. Record, to the *nearest whole degree*, the altitude of *Polaris* when it is viewed from the top of New York State's Mt. Marcy.

18. The diagram above represents Earth as viewed from space. The dashed line indicates Earth's axis. Some latitudes are labeled. On the diagram, draw an arrow that points from the North Pole toward *Polaris*.

19. Determine the number of hours it took to record the star trails labeled on the diagram.

20. Identify the motion of Earth that causes these stars to appear to move in a circular path.

Base your answers to questions **21** through **23** on the Characteristics of Stars graph in your answer booklet and on your knowledge of Earth science.

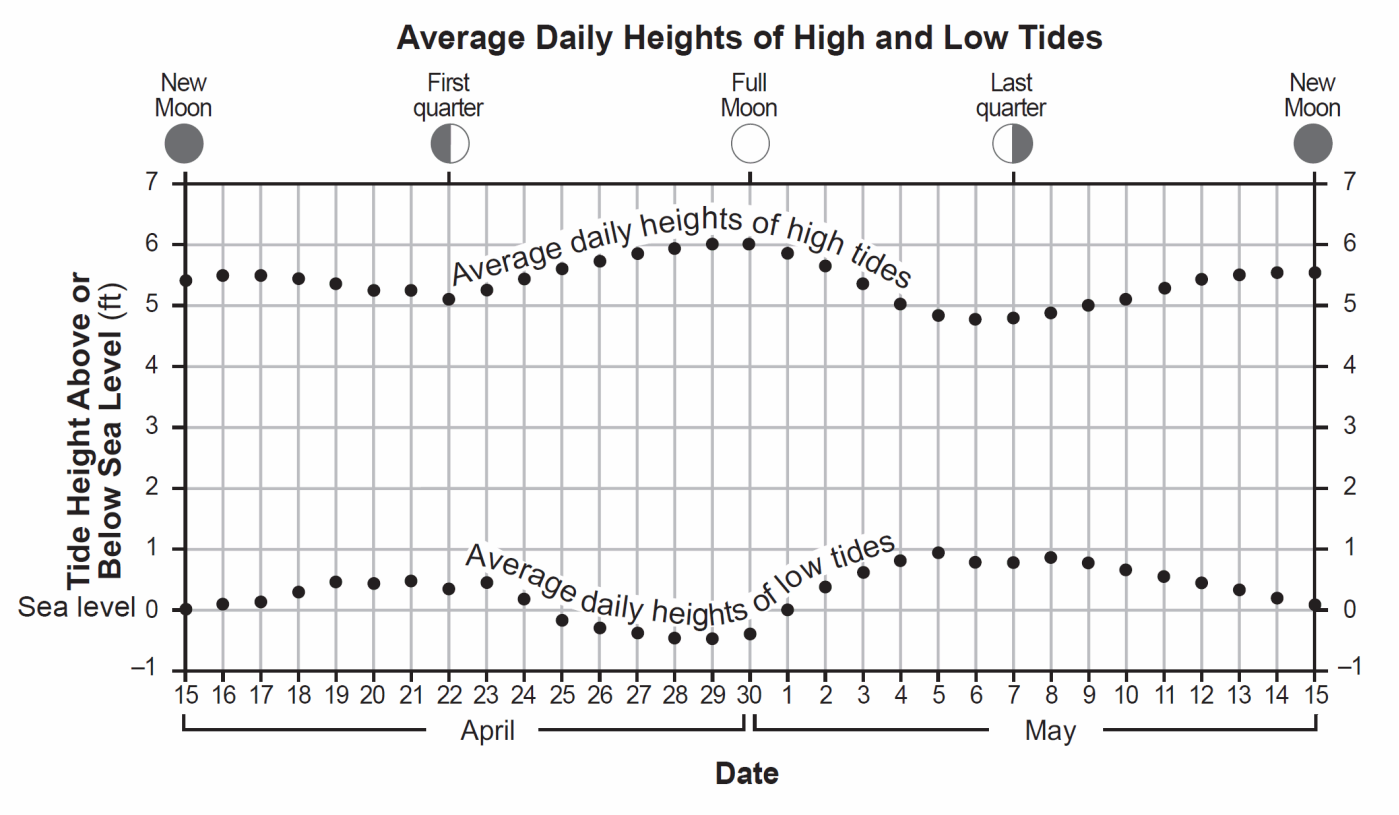


21. Describe how the relative surface temperature and the relative luminosity of *Aldebaran* would change if it collapses and becomes a white dwarflike *Procyon B*.

22. Describe *one* characteristic of the star *Spica* that causes it to have a greater luminosity than *Barnard's Star*.

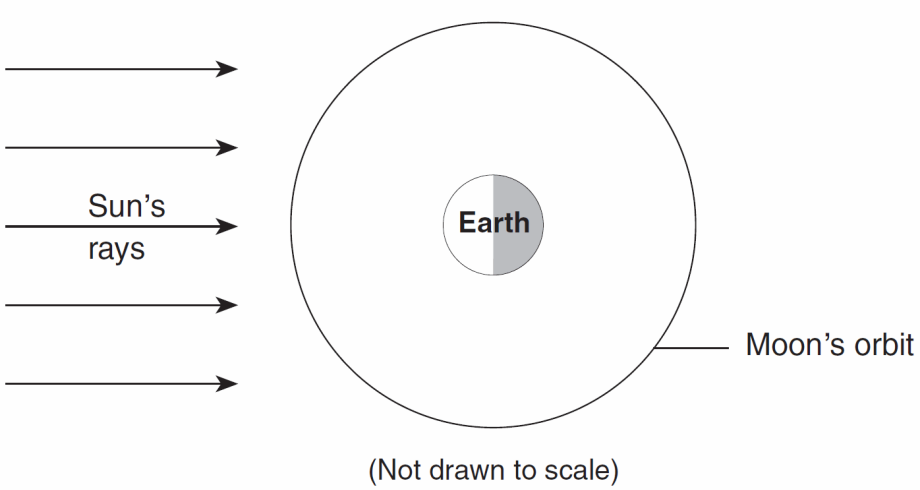
23. The star *Canopus* has a surface temperature of 7400 K and a luminosity (relative to the Sun) of 1413. Above,use an **X** to plot the position of *Canopus* on the graph, based on its surface temperature and luminosity.

Base your answers to questions **24** and **25** on the graph below and on your knowledge of Earth science. The graph shows the average daily heights above or below sea level of high and low tides from April 15 to May 15, for a New York State location. Five Moon phases are indicated at the dates on which they occurred.

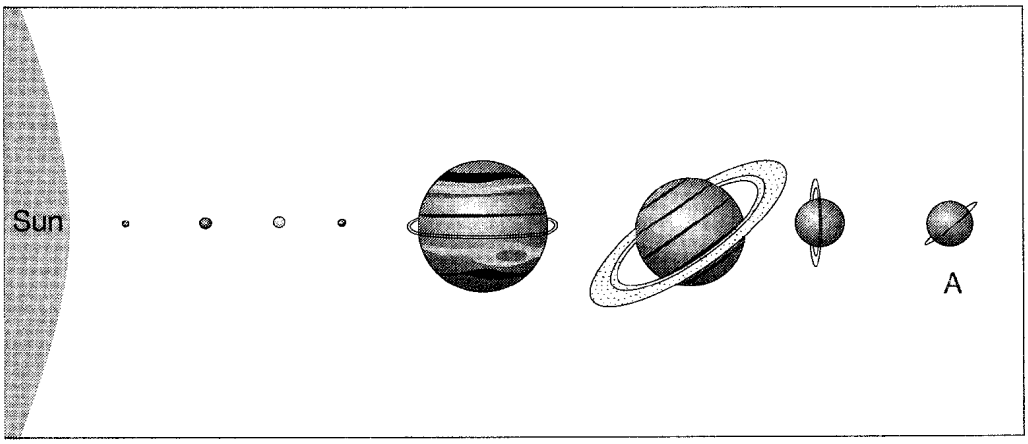


24. Infer the date when the next first-quarter Moon phase occurred.

25. On the diagram,place an **X** on the Moon's orbit to indicate the Moon's position on April 15.



Base your answers to questions **26** and **27** on the side-view model of the solar system in your answer booklet and on your knowledge of Earth science. The planets are shown in their relative order of distance from the Sun. Letter *A indicates one of the planets.*

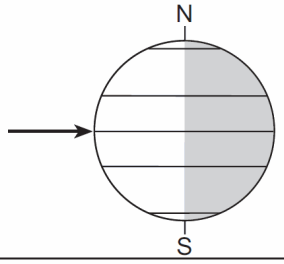
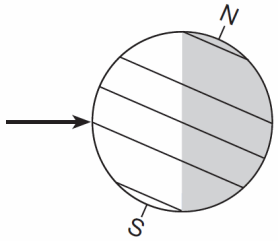
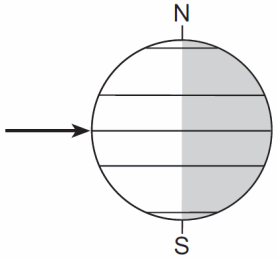
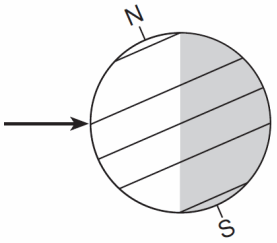


(Not drawn to scale)

26. Identify the process that occurs within the Sun that converts mass into large amounts of energy.

27. Calculate how many times larger the equatorial diameter of the Sun is than the equatorial diameter of Venus.

Base your answers to questions **28** through **31** on the table below and on your knowledge of Earth science. The table provides information about sunlight received on four dates of a certain year. Letter *A* represents a date. The arrows indicate the Sun's direct rays.

Date	Position of Earth Relative to the Sun's Rays	Seasonal Event
Sept 23		Fall equinox: Equal day and night Sun on the horizon at poles Direct ray at equator
Dec 21		Winter solstice: Area north of Arctic Circle in constant darkness
A		Spring equinox: Equal day and night Sun on the horizon at poles Direct ray at equator
June 21		Summer solstice: Area south of Antarctic Circle in constant darkness Direct ray at 23.5° N

28. Explain why the Sun's direct rays are at different latitudes as Earth revolves around the Sun.

29. State the number of daylight hours occurring north of the Arctic Circle on June 21.

30. State the numerical latitude at which the Sun is directly overhead at noon on December 21. Include the units and compass direction in your answer.

31. Identify *one* possible date represented by letter *A*.

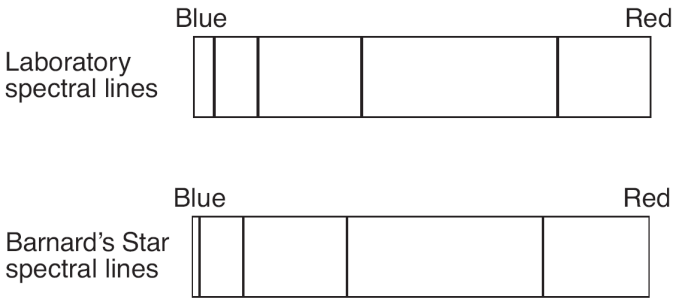
Base your answers to questions **32** through **35** on the table below, which lists some information about *Barnard's Star.*

Barnard's Star

Distance from Sun	• 6.0 light-years* • currently moving toward the Sun (and Earth) and will get as close as 3.8 light-years in approximately 11,000 years
Characteristics of Barnard's Star	• less than 17 percent of the Sun's mass • approximately 20 percent of the Sun's diameter • age thought to be between 11 and 12 billion years old and may last another 40 billion years • no planets observed orbiting Barnard's Star

* A light-year is the distance light travels in one year.

32. The diagram below shows four spectral lines produced by glowing hydrogen gas in a laboratory and four spectral lines produced by hydrogen gas as seen in the light from *Barnard's Star.*

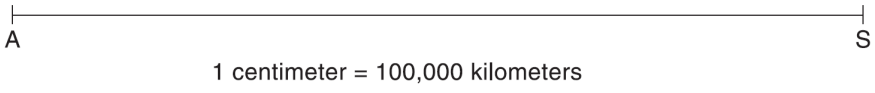


Explain why the positions of the spectral lines of *Barnard's Star* are all shifted toward the blue end of the
spectrum.

33. If a planet with the same mass as Earth were discovered orbiting *Barnard's Star* at the same distance that Earth is orbiting the Sun, why would there be less gravitational attraction between this new planet and *Barnard's Star* than there is between Earth and the Sun?

34. Compared to the surface temperature and luminosity of the Sun, describe the relative surface temperature and the relative luminosity of *Barnard's Star*.

35. The distance from point *A* to point *S* on the line belowrepresents the equatorial diameter of the Sun. On this line, place a point labeled *B* at the correct scale distance from point *A* to represent the equatorial diameter of *Barnard's Star*.

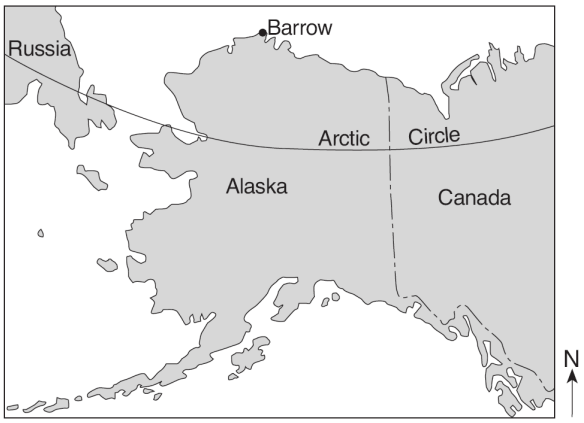


Base your answers to questions **36** through **38** on the table and map below. The table shows the duration of insolation, in hours, at Barrow, Alaska, on the twentieth day of each month during 2008. The map shows the location of Barrow at 71° N 156.5° W.

Duration of Insolation at Barrow, Alaska

Date	Duration of Insolation (h)
Jan 20	0
Feb 20	7.8
Mar 20	12.5
Apr 20	17.6
May 20	24
June 20	24
July 20	24
Aug 20	16.7
Sept 20	12.6
Oct 20	7.8
Nov 20	0
Dec 20	0

Barrow, Alaska

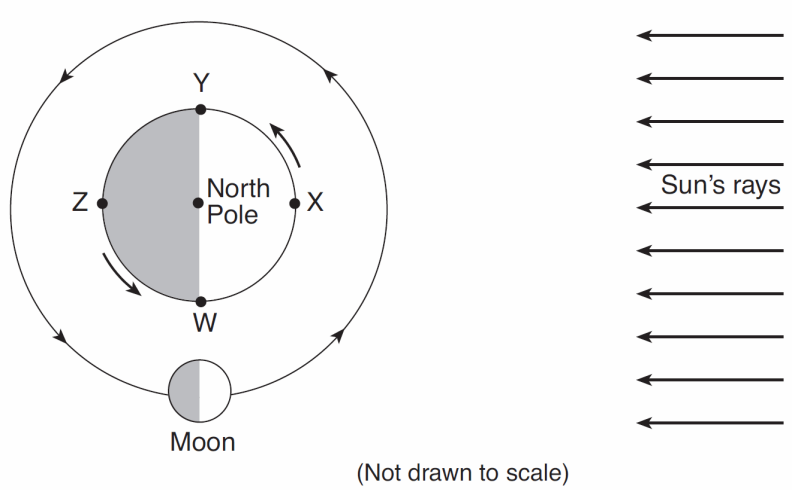


36. On what date was the noontime Sun highest in the sky at Barrow?

37. Explain why Barrow is in a different time zone than New York City.

38. State the altitude of *Polaris* as seen from Barrow.

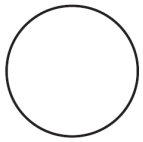
Base your answers to questions **39** through **41** on the diagram below, which shows one position of the Moon in its orbit around Earth. Letters *W*, *X*, *Y*, and *Z* are locations on Earth's surface.



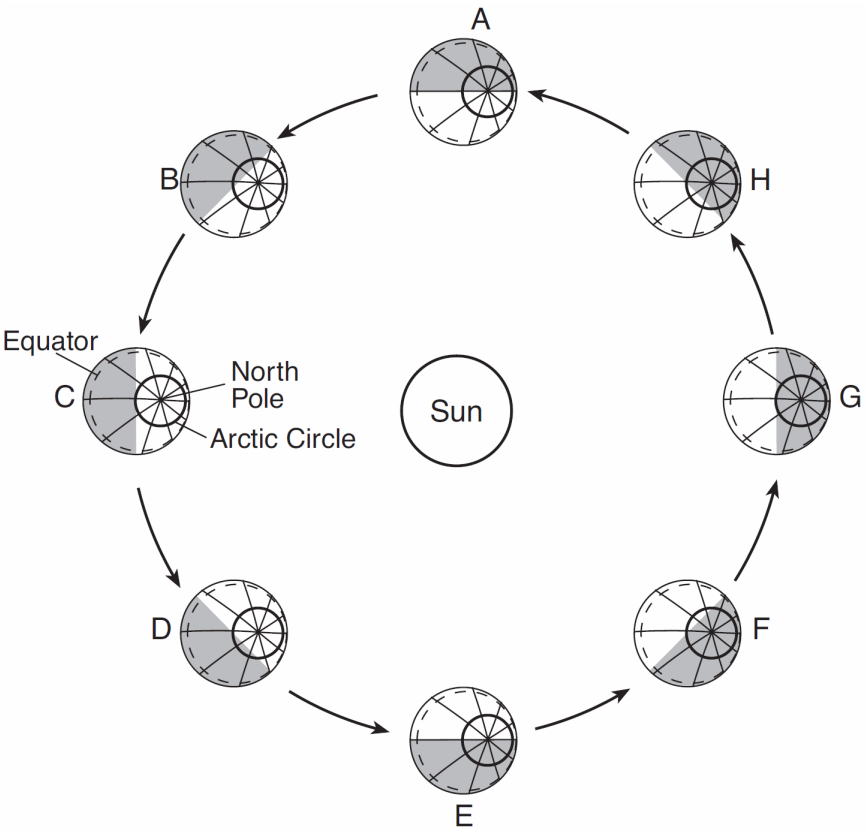
39. What is the solar time at location Y? Include a.m. or p.m. in your answer.

40. Write "high" or "low" to indicate whether a high ocean tide or low ocean tide is occurring at locations *W*, *X*, *Y*, *Z*.

41. On the diagram of the Moon below, shade the part of the Moon that appears dark to an observer in New York State when the Moon is at the position shown in the diagram above.



Base your answers to questions **42** and **43** on the diagram below, which shows Earth's orbit around the Sun as viewed from space. Earth is shown at eight different positions labeled A through H. Earth's North Pole, Arctic Circle, and equator have been labeled at position C. The arrows show the direction of orbital motion.



(Not drawn to scale)

42. Approximately how many days does Earth take to move from position *A* to position *C*?

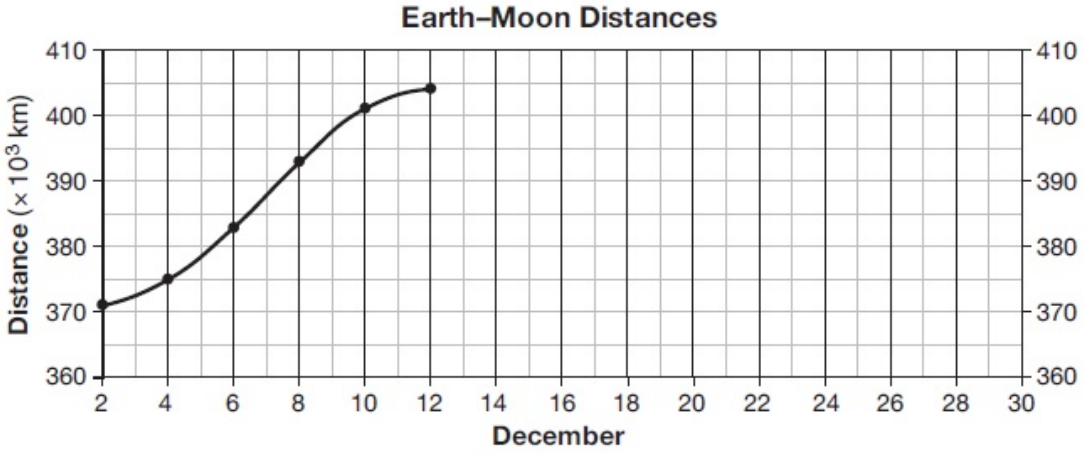
43. Complete the data table below by placing the letter that represents the position of Earth at the start of *each* season in the Northern Hemisphere.

Season	Earth's Position
spring	
summer	
fall	
winter	

Base your answers to questions **44** through **48** on the data table below and on your knowledge of Earth science. The table shows the distance from Earth to the Moon for certain days during December 2010. The percent of the Moon illuminated by the Sun as seen from Earth is also given.

Moon Data December 2010

Date December 2010	Approximate Earth–Moon Distance (x 10^3 km)	Illuminated Moon Seen from Earth (%)
2	371	12.3
4	375	1.5
6	383	1.2
8	393	10.2
10	401	25.5
12	404	44.0
14	403	63.3
16	396	81.0
18	386	94.3
20	377	100.0
22	373	99.0
24	368	80.4
26	369	70.1
28	371	47.0
30	375	24.8



44. A lunar eclipse occurred during December 2010. On which date did this eclipse most likely occur?

45. Identify *one* date during December 2010 when the Moon was at its mean distance from Earth as indicated on the *Earth Science Reference Tables*.

46. On which data shown in the data table was the gravitational attraction between the Moon and Earth the greatest?

47. Explain how the Earth-Moon distance data support the inference that the Moon's orbit is an ellipse.

48. On the grid, the Earth-Moon distance data from December 2 to December 12 have already been plotted. Complete the line graph by plotting the Earth-Moon distances from December 14 to December 30. Continue the line from December 12 through *all nine* of your plotted points.

Base your answers to questions **49** through **51** on **Extrasolar Planets**

Astronomers have discovered more than 400 planets outside of our solar system. The first extrasolar planet was detected in 1995 orbiting a star known as 51 Pegasi, which is similar in color and luminosity to our Sun. Astronomers can detect planets by identifying stars that move in response to the gravitational pull of planets revolving around them. Other planets have been discovered by finding stars whose luminosity varies as orbiting planets block outgoing starlight. Nearly all of these discovered planets are thought to be Jovian-like planets similar to Jupiter.

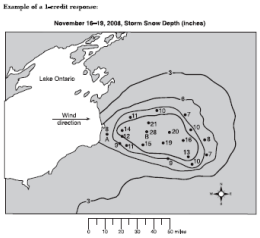
49. Compared to Jupiter, state how Earth's equatorial diameter and density are different.

50. Other than Jupiter, identify *one* Jovian planet in our solar system.

51. State the color and luminosity of *51 Pegasi.*

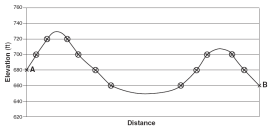
Answer Key
Review Session 7 Constructed Response

1. 0.75 in/mi - 0.85 in/mi

2. 

3. – Contour lines are extremely close together. – The most closely spaced contour lines indicate the steepest gradient.

4. D

5. 

6. Any elevation between 680 feet and 700 feet

7. southeast or SE

8. *Examples*: — Earth rotates at a rate of 15°/hr. — Earth's period of rotation is 24 hours. — Earth spins 360° in 24 hours.

9. 12 hours

10. 90°

11. 15º

12. North

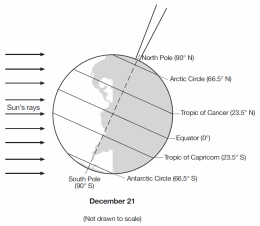
13. —The altitude of the Sun in the sky changes, —Earth rotates, —the Sun's position in the sky, —the apparent motion of the Sun

14. 130 cm - 160 cm

15. — New York State is receiving higher angles of insolation. — The Northern Hemisphere is experiencing a longer duration of insolation. — The North Pole axis or Northern Hemisphere is tilted toward the Sun. — The Sun appears higher in the sky.

16. 6 *or* six months

17. 44°

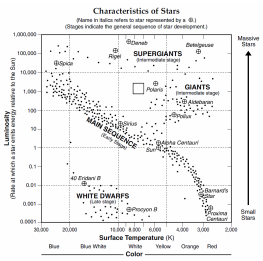
18. 

19. 4 h

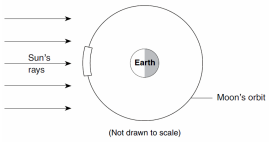
20. — rotation — spinning/turning on its axis

21. Relative surface temperature: –Alderbaran's surface temperature will increase. –It will get hotter. Relative luminosity: –Its luminosity will be reduced. –Luminosity will decrease.

22. –more massive/larger/giant size/supergiant – *Spica* emits energy at a greater rate than *Barnard's Star*. –hotter/greater surface temperature –*Spica* is a blue-colored star.

23. 

24. May 21 or May 22

25. 

26. – fusion, – nuclear fusion, – conversion of hydrogen to helium/H to He

27. – any value from 115 to 115.003305 times larger

28. — Earth's axis is tilted 23.5 degrees from a line perpendicular to the plane of Earth's orbit. — axis is tilted — Earth's axis is always parallel to itself at any other place in Earth's orbit. — parallelism of Earth's axis — Earth's axis is always aligned with the North Star (*Polaris*) as Earth orbits the Sun.

29. 24 h

30. any value from 23.4° S to 23.5° S

31. month and day of March 19 *or* March 20 *or* March 21 *or* March 22

32. — *Barnard's Star* is moving toward Earth. — Earth and *Barnard's Star* are moving closer together. — *Barnard's Star* is moving closer to the Sun.

33. — *Barnard's Star* is a smaller star than the Sun. — The Sun has more mass.

Answer Key
Review Session 7 Constructed Response

34. Relative surface temperature: — cooler — *Barnard's Star* has a lower surface temperature. Relative luminosity: — is less luminous — *Barnard's Star* is less luminous than the Sun. — emits energy at a lower rate

35. 

36. — June 20 — June 21 — June 22

37. — Barrow is approximately 80° west of New York City. — Barrow's longitude is different from New York City. — Earth rotates from west to east, so the Sun rises later in Barrow.

38. 71°.

39. 6 p.m.

40. W: high tide, X: low tide, Y: high tide, Z: low tide

41. 

42. Any value from 88 to 94 days

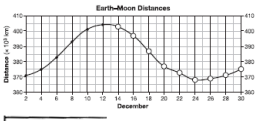
43.

44. —December 20, 2010, —December 21, 2010

45. —December 6, 2010, —December 7,2010, —December 18,2010

46. December 24, 2010

47. —The Earth-Moon distance varies in a regular patter. —The Earth-Moon distance is not constant. —A circular orbit would have the same distance throughout the month. —The Earth-Moon graph increases, then decreases.

48. 

49. Diameter: smaller, Density: greater

50. Saturn, Uranus, *or* Neptune

51. Color: yellow, Luminosity: 1