

1. Which of the following statements is incorrect concerning sidereal days and solar days?
  - A. One sidereal day is defined as the time taken for the Earth to make one complete rotation on its axis
  - B. One sidereal day is 3.9 minutes longer than one solar day
  - C. The time difference between one sidereal day and one solar day accounts for the daily slight shift in the position of stars
  - D. The time difference between one sidereal day and one solar day is due to the simultaneous rotation of the Earth about its axis and the revolution of Earth around the Sun

2. The Earth's aphelion is the position of the Earth on its orbit that is most distant from the Sun.

At which time of the year is the Earth furthest from the Sun?

- A. 3 January
  - B. 21 June
  - C. 3 July
  - D. 21 December
3. Which of the following statements is incorrect regarding solar eclipses?
    - A. During a total solar eclipse, the corona of the Sun becomes visible.
    - B. If the umbra region of the eclipse does not reach the Earth, an annular eclipse will be seen
    - C. A solar eclipse track on Earth runs from the west to the east
    - D. An eclipse that occurred in December 4, 2002 will be seen again in December 14, 2018, in accordance with the Saros cycle
  4. The Milankovitch cycles concern about the movement of Earth on its axis and its orbit around the Sun. These cycles include the Earth's orbit eccentricity, its precession period and its obliquity.

Which of the following phenomena is not explained by the Earth's precession cycle?

- A. The advance and retreat of glacial periods.
- B. The changes in the tilt of the Earth's axis
- C. The shift of the Earth's "North Star" from Thuban to Polaris
- D. The time difference between one sidereal year and one solar year.

5. Nicolaus Copernicus revolutionized astronomy of his era when he rediscovered and proposed the heliocentric model of the solar system.

Which of the following was not one of the foundations of the then Copernican revolution?

- A. The celestial spheres do not have just one common centre.
  - B. The motions of the Sun are not its motions, but the motion of Earth.
  - C. The Earth follow an elliptical orbit in its revolution around the Sun
  - D. What appears to us as retrograde and forward motion of the planets is not their own, but that of Earth.
6. The electro-magnetic spectrum is one of the primary resources where astronomers gain information about the Universe. However, due to the spectral opacity of the Earth's atmosphere, not all electromagnetic spectrum from the cosmos reaches the surface of Earth.

To which ranges of the electromagnetic spectrum is the Earth's atmosphere transparent?

- A. Visible light and long radio waves
  - B. Visible light and far infrared radiation
  - C. Visible light, short radio waves and near infrared radiation
  - D. Visible, X-rays, short radio waves and near infrared radiation
7. Who was responsible in laying out the fundamentals of a simple telescope?
- A. Roger Bacon
  - B. Hans Leppershey
  - C. Galileo Galilei
  - D. Sir Isaac Newton
8. How much more light would a 2 meter diameter telescope gather in a certain amount of time at a given wavelength compared with one that is 50 centimetres in diameter?
- A. 2 times more
  - B. 4 times more
  - C. 16 times more
  - D. The same amount

9. Determining the range of electromagnetic spectrum frequency when choosing telescopes depends on the subject of the study.

What is the best frequency range of the electromagnetic spectrum in which to study the extremely hot gas found among the galaxies in the Virgo cluster?

- A. The gamma ray region of the spectrum
  - B. The X-ray region of the spectrum
  - C. The infrared region of the spectrum
  - D. The radio region of the spectrum
10. The *Voyager* spacecrafts were instrumental in revolutionizing our understanding on the Jovian planets.

Which of the Jovian planets had been visited by *Voyager 2* but not *Voyager 1*?

- A. Jupiter and Saturn
  - B. Saturn and Uranus
  - C. Uranus and Neptune
  - D. Neptune and Jupiter
11. Which of the following statements is not true regarding the Moon?
- A. There are 14 maria on the Moon, each bearing Latin names
  - B. The highland rocks are thought to be of older origin than those in the maria
  - C. The highland rocks contain more iron, while maria rocks are rich in aluminium
  - D. The side of the Moon that is unobservable from Earth (the far side) has no major maria
12. Which of the following planets has the most circular orbit?
- A. Venus
  - B. Earth
  - C. Jupiter
  - D. Neptune
13. Despite the fact that Venus is similar in terms of size, composition and geological activity in relation to Earth, it virtually does not have a magnetosphere. Why is this so?

- A. The planet rotates too slowly
- B. The planet lacks a molten core
- C. The planet does not have plate tectonics
- D. The planet's core contains little or no iron

14. Although Mars is quite bright and easily seen at times in the sky, it is still considerably fainter than Venus.

Which of the following reasons does not account for this observation?

- A. Mars is further away from the Sun than Venus is
- B. Mars has less surface area compared to Venus to intercept sunlight
- C. Mars is much less reflective compared to Venus
- D. Mars contains a lot of iron on its surface that absorbs sunlight efficiently

15. Jupiter possesses the most natural satellites than any other planets in the solar system. However, it is Jupiter's four Galilean moons that have been studied most extensively.

Which of the following statements is untrue with respect to Galilean moons?

- A. In ascending order of distance from Jupiter, the satellites are Io, Europa, Ganymede and Callisto
- B. In ascending order of size, the satellites are Europa, Io, Callisto, and Ganymede
- C. In ascending order of density, the satellites are Io, Europa, Ganymede and Callisto
- D. In ascending order of apparent brightness, the satellites are Ganymede, Io, Europa and Callisto

16. What will happen if a moon is placed within a planet's Roche limit?

- A. It will not rotate
- B. It will break into smaller pieces
- C. It will develop geological activities and subsequently a magnetic field
- D. It will flatten into a disc due to the planet's gravitational field

17. Saturn is considered to be one of the most beautiful and complex planets in the Solar System, largely due to its system of moons and rings.

Which of the following statement is untrue regarding the moons and rings of Saturn?

- A. Although Saturn's ring system is tens of thousands of kilometers wide it is only a few tens of meters thick
  - B. Two small shepherd satellites are responsible for the usually complex form of Saturn's F ring
  - C. The moons Telesto, Tethys and Dione share one synchronous orbit around Saturn
  - D. The moon Hyperion tumbles in an unpredictable way as it orbits Saturn
18. Astronomers adopt a convention that a planet's (or a satellite's) rotation is always counterclockwise as seen from the north pole. Otherwise, the planet is said to be in a retrograde motion.

Which of the following planets have retrograde rotations?

- A. Venus
  - B. Uranus
  - C. Pluto
  - D. All of the above
19. A meteoroid swarm is the remnants of dislodged cometary fragments from a parent comet. When the Earth's orbit intersects with theirs, a spectacular meteor shower can result.

Which of the following is incorrect regarding the meteor shower, its day of maximum activity, and its parent comet?

Meteor shower	Day of maximum activity	Parent comet
A. Lyrids	21 April	Encke
B. Eta Aquarids	4 May	Halley
C. Orionids	20 October	Halley
D. Taurids	7 November	Encke

20. While most of the asteroids in the Solar System concentrate within the asteroid belt, some asteroids have orbits that deviate from the usual trajectory. These asteroids are collectively grouped according to their orbital range.

Which orbit of the following asteroid groups does not intersect the orbit of Mars?

- A. The Amors

- B. The Apollos
- C. The Atens
- D. The Centaurs

21. The Sun can be divided into several layers based on density, temperature and visible properties.

Of the following statements about the layers of the Sun, which is false?

- A. The photosphere is denser than the chromospheres.
- B. The corona is hotter than the chromospheres
- C. The chromospheres is the part of the Sun we can normally see
- D. The solar wind's temperature can reach up to 2 000 000 K

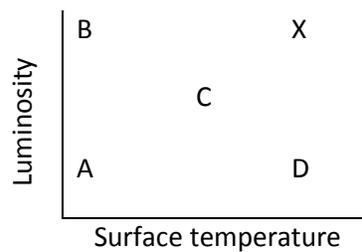
22. I: Sirius II: Procyon III: Antares IV: Rigel Kentaurus V: Barnard's Star

Featured above are five stars well known to night sky observers.

In ascending order of distance from Earth, the arrangement would be:

- A. IV, V, I, II and III
- B. IV, I, II, III and V
- C. IV, II, III, V and I
- D. IV, III, V, I and II

For questions 23 and 24, refer to Figure 1.



**Figure 1**

23. Between the regions A, B, C, and D, which region does the star Sirius B fall on?

24. Which of the following stars does not fall on region X?

- A. Antares

- B. Arcturus
  - C. Deneb
  - D. Mira
25. Cepheid variables are more useful than RR-Lyra variables in establishing distances beyond those in our own galaxy. Why is this so?
- A. Cepheid variables obey a period luminosity relationship but RR-Lyra stars do not
  - B. Cepheid variables are much more luminous than RR-Lyra variables because they have much larger surface areas
  - C. RR-Lyra stars have a variation period that is so short it cannot be measured as accurately as for Cepheid variables
  - D. RR-Lyra stars are expected to be much more numerous in our galaxy than in our nearby neighbour galaxies because they are normally found in globular clusters
26. For a star of one solar mass, what does the evolutionary track on the H-R diagram while contracting to the main sequence indicate?
- A. The star moves almost horizontally to the left until joining the main sequence
  - B. The star first increases and then decreases in luminosity until reaching the main sequence
  - C. The star starts at the far left of the HR diagram and moves horizontally until joining the main sequence
  - D. The star begins in the white dwarf region, then moves to the region of planetary nebula, and finally drifts to the main sequence
27. Stars spend a larger percentage of their life on the main sequence than any other region due to the stability of the main sequence stage.

What is the primary reason for the stability for main sequence stars?

- A. The large percentage of their energy coming from gravitational contraction, which is a very smooth process
- B. The hydrogen fusion reaction is strongly temperature dependent
- C. Their cores are mostly made of iron, the most stable element
- D. Their hydrogen is almost completely ionised

28. Pulsars exhibit a 'lighthouse effect', i.e. they emit radiation that seems to be concentrated at their two poles.

What is this phenomenon associated with?

- A. The strong gravitational field of the neutron star
- B. The strong magnetic field of the rotating neutron star
- C. The enormous gravitational field of the black hole inside the pulsar
- D. Thermonuclear explosions on the surface of the central white dwarf star

29. The 'event horizon' surrounding a black hole is associated with the...

- A. Accretion disk
- B. Schwarzschild radius
- C. Space-time singularity
- D. Kerr metric

30. Could the Earth become a black hole?

- A. No, only stars can form black holes
- B. No, because black holes are always parts of binary star systems
- C. Yes, if it were compressed to a high enough density
- D. Yes, but only if a large amount of mass (at least that of the Sun) were added to it

31. Gas about to cross through the event horizon of black hole emits radiation in the form of an emission line.

What would be the appearance of the radiation?

- A. It will appear red-shifted
- B. It will appear blue-shifted
- C. It will be split into many emission lines
- D. It will be unobservable via spectrometry

32. Orion is perhaps the most well known constellation in the Winter Sky of the Northern Hemisphere.

Which of the following star does not belong to that constellation?

- A. Bellatrix
- B. Mintaka
- C. Saiph
- D. Turais

33. Which of the following stars is not the beta star of their respective constellations?

- A. Altarf – Cancer
- B. Graffias – Scorpius
- C. Hamal – Aries
- D. Pollux – Gemini

34. The shape of a galaxy can provide an astronomer some clues about its age and interstellar material.

Which of the following galaxy types consist of population II stars only?

- A. Spiral and lenticular galaxies
- B. Lenticular and elliptical galaxies
- C. Elliptical and irregular galaxies
- D. Irregular and spiral galaxies

35. The hypothetical galaxy AB1234 is a spiral galaxy with one inner and one outer spiral arm.

Which region of AB1234 would you most probably find star clusters that contain elements such as neon and magnesium?

- A. The inner arm region
- B. The outer arm region
- C. The galactic halo region
- D. The galactic disk region

36. One of the most interesting areas in astronomical research is the search for the so-called dark matter that accounts for the missing mass of the Universe.

Which of the following is the leading candidate to account for the dark matter?

- A. Quasars

- B. MACHOs
  - C. Black holes
  - D. Faint nebulae
37. What distinguishes Irr II galaxies (Irregular galaxies type II) from Irr I galaxies?
- A. Irr II galaxies are more massive than Irr I galaxies in terms of size
  - B. Irr II galaxies often look like misshapen spirals more than Irr I galaxies
  - C. Irr II galaxies usually have an explosive or filamentary appearance, while Irr I galaxies do not
  - D. Irr II galaxies contain only young stars, while Irr I galaxies contain both young and old stars
38. Which of the following does not define the Hubble constant?
- A. It is the reciprocal of the age of the Universe
  - B. It is the constant of proportionality in Hubble's Law
  - C. It specifies the rate at which an entire galaxy expands
  - D. It is the gradient of the straight line graph of recessional velocity against distance
39. Which of the following, both explicit and implicit, is not one of the assumptions of the cosmological principle?
- A. The universe is homogeneous on scales greater than a few hundred Mpc
  - B. The universe appears to be the same in all directions on large scales
  - C. The laws of physics are the same everywhere within the universe
  - D. The universe expands at a constant rate
40. In the 1980s, the original Big Bang theory was challenged by two problems: the flatness problem and the horizon problem. However, a new theory was created to address these problems, and it was very successful.

What is the name of that particular theory>

- A. The steady-state theory
- B. The oscillating universe theory
- C. The inflationary universe theory
- D. The grand unified theories (GUTs)

## Section B

41. "On July 1, 2004 UTC, the Cassini-Huygens spacecraft fired its main engine to reduce its speed, allowing the spacecraft to be captured by Saturn's gravity and enter orbit. The spacecraft is now on a four-year mission to explore the ringed planet, its mysterious moons, the stunning rings and its complex magnetic environment." – Taken from <http://saturn.jpl.nasa.gov/operations/index.cfm>

The Cassini will or have made flybys to the following moons, except...

- A. Janus
  - B. Dione
  - C. Tethys
  - D. Enceladus
42. "The last planet found in our solar system remains the only one never visited by an Earth probe – but NASA's *New Horizons* mission hopes that distinction won't last much longer. [However,] a one-year launch delay would actually mean a three-year push in arrival time." – Modified from [http://news.nationalgeographic.com/news/2005/02/0215\\_050\\_14\\_pluto.html](http://news.nationalgeographic.com/news/2005/02/0215_050_14_pluto.html)

Which of the following explains the underlined statement best?

- A. A delay means that a direct trajectory to Pluto will be blocked by Neptune
  - B. A delay means that the spacecraft miss the gravity boost given by Jupiter
  - C. A delay means that Pluto will be orbiting away from the planned position
  - D. A delay means that it will need to overcome Saturn's gravitational field
43. "It is the most distant object in the solar system ever identified – travelling around the sun every 10 500 years in a highly elliptical orbit that keeps it 7 billion to 93 billion miles from Earth. Nothing else that far out has ever been seen."

The following questions regarding the object remains unanswered, except that...

- A. ... whether the object is a part of the long hypothesized Oort Cloud
- B. ... how, when and where the object was formed
- C. ... why the orbit of the object is highly eccentric
- D. None of the above

44. "Moving at more than 670 kilometres per second, it [a star] is moving directly away from the centre of the galaxy. The star took about 80 million years to go from the galactic centre to its present location, and it is at least that old, the observations show. Finally, the star is laden with heavy elements..." – *modified from*  
[http://space.com/scienceastronomy/escaping\\_star\\_050208.html](http://space.com/scienceastronomy/escaping_star_050208.html)

Basing only on the excerpt, what can be implied about the fast moving star?

- A. It was once a part of a binary star system
  - B. It will eventually escape the galaxy and enter the intergalactic space
  - C. It came from a star-forming region, either at the galactic disk or centre
  - D. It received its enormous speed after interacting with a massive black hole
45. "NASA's *Deep Impact* mission, which will crash a projectile into Comet Tempel 1, has launched from Cape Canaveral. The projectile will collide with the comet on 4 July – 24 hours after its release – travelling at 37,000km/h. it could punch a crater in the comet big enough to swallow Rome's Coliseum." – *Taken from* <http://news.bbc.co.uk/2/hi/science/nature/4162869.stm>

What is the purpose of the *Deep Impact* mission?

- A. To divert the comet from a collision course with Earth
  - B. To investigate the comet debris collected from the explosion
  - C. To find out more about the comet's interior structure and composition
  - D. To investigate the effects of cratering on a comet's motion and trajectory
46. "Astronomers have identified the three biggest stars known to science. If they were located in the same place as our own Sun – at the centre of the Solar System – the stars would stretch out further than the orbit of Jupiter. The red "supergiant" stars are KW Sagittarii (9,800 light-years away), V354 Cephei (9,000 light-years away), and KY Cygni (5,200 light-years away)." – *Taken from* <http://news.bbc.co.uk/2/hi/science/nature/4164365.stm>.

Which of the following was the previous record holder for the biggest star?

- A. Herschel's Garnet star
- B. Barnard's star
- C. Betelgeuse
- D. Rigel

47. "In 2001, astronomers reported that fast-spinning Altair, a white star of spectral type A7, has an equatorial diameter 14% greater than its polar diameter... And in 2003, astronomers discovered the equatorial diameter of the blue B3 main sequence star Achernar is 56% greater than its polar diameter. In fact, Achernar is still the flattest star known." – *Taken from*

In 2004, astronomers have found yet another oblate (flattened) star due to its high rotational speed. What is the name of the star?

- A. Spica
- B. Antares
- C. Regulus
- D. Procyon

48. "To penetrate all the way back to the era when galaxies first began to assemble will require the completion of Hubble's successor: the James Webb Space Telescope, which is currently scheduled to launch in 2011." – *Taken from*  
[http://skyandtelescope.com/news/article\\_1356\\_1.asp](http://skyandtelescope.com/news/article_1356_1.asp).

At what wavelength will the James Webb Space Telescope function?

- A. Ultraviolet
- B. Visible
- C. Infrared
- D. Radio

49. "By teasing out a loose congregation of faint stars in Ursa Major, a team led by Beth Willman (NYU) has discovered the Milky Way's 13<sup>th</sup> known satellite galaxy. The Ursa Major galaxy is a dwarf just 1,600 light-years wide. It shines with the feeble intensity of only 40,000 Suns, making it the lowest luminosity galaxy ever detected." – *Taken from*  
[http://skyandtelescope.com/news/article\\_1493\\_1.asp](http://skyandtelescope.com/news/article_1493_1.asp).

Which of the following is not a satellite galaxy of the Milky Way?

- A. Large Magellanic Cloud
- B. Ursa Minor
- C. Fomalhaut
- D. Leo II

50. "The team's data confirm what other studies have shown: The expansion of the universe slowed down in the period after the Big Bang, then began to accelerate about 6 billion years ago. This acceleration is the hallmark of dark energy, which acts like a repulsive force, pushing everything apart." – Taken from [http://skyandtelescope.com/news/article\\_1261\\_1.asp](http://skyandtelescope.com/news/article_1261_1.asp).

Combined with dark matter, what is the approximate percentage of dark matter and energy available in the universe?

- A. 65%
- B. 75%
- C. 85%
- D. 95%