ASTROCHALLENGE 2016 MULTIPLE CHOICE QUESTIONS
JUNIOR ROUND

INSTRUCTIONS

- This paper consists of 12 printed pages, excluding this cover page.
- Do **NOT** turn over this page until instructed to do so.
- You have 2 hours to finish all questions in this paper. Choose the most appropriate answer
- At the end of the paper, staple this booklet together with your answer script.
- Your answer script should clearly indicate your name and school.
- It is your team's responsibility to ensure that all pages of your answer script have been submitted.

1. The total mass of the solar system is roughly on the order of

   A. 2×10^{29} kg
   B. 2×10^{30} kg
   C. 2×10^{31} kg
   D. 2×10^{32} kg
   E. 2×10^{33} kg

2. How large is the angular separation between Sun and Moon 2 days after a New Moon? Assume that the Earth-Moon-Sun lie in the same plane.

   A. 102°
   B. 51°
   C. 25.5°
   D. 0.85°
   E. Cannot be determined

3. Given the situation in Question 2, where in the sky can the Moon be observed if the Sun is seen to be setting near the horizon? Assume that the declination of the Moon is similar to that of the Sun.

   A. Above the ground, due West
   B. Above the ground, due East
   C. Above the ground, around Zenith
   D. Above the ground, close to the Sun
   E. It is always underground and cannot be seen

4. Below are the characteristics of a star that can be observed with the naked eye in Singapore.

   - It is a red supergiant.
   - It can be seen rising in the East just after sunset during December.
   - This star forms a common asterism with Sirius and Procyon.

   What is this star?

   A. Pollux
   B. Arcturus
   C. Alpha Centauri
   D. Aldebaran
   E. None of the above

5. Planetary interiors are differentiated because

   A. Heavier elements sank to the core while the planet was still molten.
   B. Heavier elements condensed to form planetary seeds before lighter elements could come in.
   C. Lighter elements were brought to the planet much later after it formed.
   D. Lighter elements do not mix with heavier elements.
   E. Chemical reactions result in boundary separation of the elements

6. A star has a parallax of 50 milliarcseconds and an apparent bolometric magnitude of 0.86. The absolute magnitude of this star is around

   A. 0.43
   B. -0.43
   C. -0.64
   D. -5.65
   E. Insufficient information to answer the question.

7. Given that the orbital period of Halley's Comet is 75.32 years, the semi-major axis of Halley's comet is thus approximately:

   A. 17.8 AU
   B. 71.2 AU
   C. 75.32 AU
   D. 653.7 AU
   E. Insufficient information to answer the question

8. Where do asteroids in the asteroid belt come from?

   A. Leftover planetesimals from the Oort cloud.
   B. A planet between Mars and Jupiter that broke up.
   C. Leftover planetesimals from the inner solar system.
   D. They originate from small moons that escaped from planets.
   E. They are objects from interstellar space captured by the sun's gravity.

9. Meteorite dating suggests that the age of our solar system is approximately

   A. 6,000 years
   B. 4.6 million years
   C. 13.78 million years
   D. 4.6 billion years
   E. 13.78 billion years

10. The sun and the planets rotate and orbit mostly in the same direction because

    A. The magnetic fields of the sun and planets cause them to rotate and orbit in the same direction.
    B. The sun and planets retain the initial angular momentum of the solar nebula.
    C. A violent collision with another star caused the sun and planets to orbit in the same direction.
    D. The rotation of the sun causes frame dragging of the planets.
    E. That is not true. The sun and planets largely rotate and orbit in opposite directions.

11. Volcanism is more likely on a rocky planet that

    A. Has higher internal temperatures
    B. Is closer to the Sun
    C. Is in an orbital resonance with its moons
    D. Does not have an atmosphere or oceans
    E. Has a highly tilted axis of rotation

12. It is known that the Sun is able to produces most of its energy by:

    A. Nuclear fusion of helium nuclei
    B. Nuclear fusion of hydrogen nuclei
    C. Nuclear fusion of carbon/nitrogen/oxygen nuclei
    D. Nuclear fission of helium nuclei
    E. Nuclear fission of hydrogen nuclei

13. Which of the following phrases is the **best** definition for a white dwarf?

    A. A radio source emitting short intense bursts of radio waves at regular intervals.
    B. A star that has collapsed under its own gravity to a diameter of about 10 to 15 km. It is composed mostly of neutrons, has a mass of between 1.4 and about 3 times that of the sun, and a density in excess of 10^{17} kilograms per cubic metre.
    C. A star that explodes catastrophically owing to either instabilities following the exhaustion of its nuclear fuel or gravitational collapse following the accretion of matter from an orbiting companion star, becoming for a few days up to one hundred million times brighter than the sun.
    D. A star in an intermediate stage of evolution, characterized by a large volume, low surface temperature, and reddish hue.
    E. A star that is approximately the size of the earth, is supported by electron degeneracy pressure, and is in the final stage of evolution for low-mass stars.

14. Which of the following celestial bodies is currently believed to be the least viable for life?

    A. Mars
    B. Venus
    C. Titan
    D. Europa
    E. Enceladus

15. Which of the following facts about a rare periodic comet is false?

    A. You would expect its dust tail to be curved, due to loss of particulate ice and dust from the comet surface (the 'dirty snowball'), and thus appears more prominent when observed.
    B. You would expect its gas or ion tail to be almost straight and pointing away from the Sun.
    C. If the comet collided with an asteroid while moving away from us, resulting in an eccentricity of 1.13, we will never see it again.
    D. If the comet reaches aphelion at 99 AU away from the Sun and perihelion at 1 AU away, it must have an eccentricity of 0.98.
    E. If the comet reaches aphelion at 200 AU away from the Sun and perihelion at 0.5 AU away, it must have an eccentricity of 0.95.

16. Earth is closest to Venus during a(n) _____ with Venus, while Earth is furthest from Saturn during a(n) _____ with Saturn

    A. Opposition, Opposition
    B. Inferior conjunction, Opposition
    C. Superior conjunction, Opposition
    D. Inferior conjunction, Conjunction
    E. Superior conjunction, Conjunction

17. Which of the following factor is NOT part of the Drake equation, used to estimate the number of active and communicating extra-terrestrial civilisations?

    A. Rate of formation of suitable main-sequence stars in galaxies
    B. Fraction of stars capable of supporting planets
    C. Number of habitable planets with life by which intelligent life develops
    D. The lifespan or time length of communicating, intelligent alien civilizations
    E. All of the above factors are part of the Drake Equation

18. A lazy student wrote that the present distance between the Sun and Jupiter is 42. What unit must you put in to ensure that his answer can actually be correct, depending on Jupiter's position in its current orbit?

    A. Million kilometres (×1,000,000 km)
    B. AU
    C. Light minutes
    D. Parsecs
    E. None of the above units will make sense.

19. Which of the following type of wavelengths will you expect to be observable by equipment in space only?
    A. UV
    B. X-rays
    C. UV and X-rays
    D. Intermediate radio waves
    E. All of the above can be observed with relative ease on Earth.

20. A common mistake by the layman is to identify objects in the night sky erroneously as man-made satellites. As light pollution in cities washes out most stars, man-made satellites tend to be more prominent. Some satellites could even have comparable brightness to planets like Venus or stars such as Sirius. Which of the statements can allow you to properly distinguish man-made satellites from authentic celestial objects?

    i. Man-made satellites, more often than not, will move across the sky at a fast speed that should not happen to stars and planets.

    ii. In comparison to planets and stars, man-made satellites are insignificantly smaller in physical size. Thus, even with the reflection of sunlight, it is theoretically impossible to see man-made satellites on Earth. That is, the context given in the text above is inaccurate.

    iii. Man-made satellites usually remain visible for a brief period of time (in the range of a few minutes). This is sometimes known as an iridium flare. This should not happen to stars and planets.

    iv. The trajectory of the man-made satellite does not follow the same motion as that of the stars and planets.

    A. ii only
    B. iv only
    C. ii and iv only
    D. i, ii and iv only
    E. i, iii and iv only

21. Binoculars are useful visual aids in astronomy. The two vital statistics on a pair of binoculars are the magnification and the diameter of the front objective lens. For example, a pair of binoculars stated as 10 × 50 has 10 times magnification and 50mm front objective lens. However, a larger magnification is not always good because it leads to…

    A. Larger apparent field of view.
    B. Dimmer objects as light is now spread over a bigger apparent image.
    C. Lowered image resolution due to the Rayleigh criterion.
    D. Increased sensitivity to light pollution.
    E. None of the above.

22. Nebula A has an angular radius of 100’ while nebula B has an angular radius of 50’. However, both nebulae have the same apparent magnitude. Which of these nebulas are theoretically easier to observe on Earth?

    A. Nebula A
    B. Nebula B
    C. Both are equally easy to observe.
    D. The ranking depends on telescope specification.
    E. Insufficient information to answer the question.

23. The Cosmic Microwave Background:

    A. Is not predicted by the Big Bang Model.
    B. Has an emission spectrum that is drastically different from a black body.
    C. Is perfectly homogenous at all scales.
    D. Shows that widely separated regions of the Universe have similar properties, creating the horizon problem.
    E. None of the above are true.

24. Which of the following statements about the Kuiper Belt are false?

    A. The Kuiper Belt is a disc of material that extends beyond Neptune’s orbit, containing predominantly small icy bodies (known as Kuiper Belt Objects, or KBOs).
    B. KBOs are not confined to the plane of the ecliptic.
    C. Neptune is gradually “clearing out” the entire Kuiper Belt, causing the Kuiper Belt to be the current main source of short-period comets.
    D. Due to the gravitational influence of Neptune, KBOs cannot exist in certain orbits, creating gaps in the Kuiper Belt (similar to the asteroid belt’s Kirkwood gaps).
    E. As a Trans-Neptunian Object (which are governed by orbital resonances with Neptune), the orbit of Pluto is stable.

25. As part of my star collection, I (somehow) managed to collect the following:

    1) A brown dwarf
    2) A red dwarf
    3) A white dwarf
    4) A black dwarf
    5) A red giant

Which of the stars in my collection are undergoing hydrogen fusion?

A. 5 only
B. 2, 3 and 4 only
C. 2 and 5 only
D. 1, 2, 3 and 5 only
E. None of the stars are undergoing hydrogen fusion

26. A type II supernova will form if and only if:

A. A star reaches the Eddington Luminosity and blows off its outer layers.
B. A star commences carbon fusion in its core.
C. Its supply of hydrogen in the core is exhausted.
D. A white dwarf accumulates too much mass.
E. The mass of the star's iron core exceeds the Chandrasekhar limit.

NB: if and only if means that if one statement is true, the other is also true

27. After studying Sirius A, you found that Sirius A is a main sequence star with a surface temperature of 9900K and an apparent magnitude of -1.47.

    I now wish to measure its distance. Which of the following procedures will allow me to do so accurately?

A. Find the associated spectral class of Sirius A. The associated main sequence absolute magnitude is then known. By comparing this absolute magnitude to the apparent magnitude, we can determine its distance.
B. Study the star for periodic variations in brightness. Find the period of these variations, and then use the known period-luminosity relationship for Cepheids. With its luminosity known, we can then determine its distance.
C. Measure the apparent position of Sirius relative to background stars, and then repeat the same procedure 1 year later. We can then measure the displacement of Sirius A relative to the background, giving us its annual parallax and thus its distance.
D. As a main sequence star, we know that the absolute magnitude of Sirius A is that of RR Lyrae stars. We thus can easily determine its distance by comparing this value to its apparent magnitude.
E. Measure the recessional velocity of Sirius A. We then calibrate the Tully-Fisher relation using stars with known luminosity and velocity (e.g. the Sun). By plugging in Sirius A's recessional velocity into the formula, we can determine its actual luminosity and distance.

28. I have a C8 SCT (2100mm focal length, 200mm aperture). Which eyepiece should I use to observe Jupiter with the maximal optimal magnification? You may find it useful that the maximal magnification for a telescope is given by 50 × aperture (in inches).

    A. 3.5mm
    B. 6mm
    C. 13mm
    D. 25mm
    E. 31mm

29. Among these statements, what is the best line of evidence that the Perseid meteors originate from a comet?

    A. They display greater levels of activity after local midnight.
    B. They all appear to originate from a common point in Perseus.
    C. They show quickly varying levels of activity over the span of several hours.
    D. They are known to leave prominent trains in the atmosphere after burning up.
    E. They all share the same highly eccentric and inclined orbit.

30. One of the advantages of a full moon is that:

    A. It makes all astronomical objects brighter and easier to observe.
    B. It allows us to perceive height contrasts between lunar mountains.
    C. It increases the contrast between nebulosity and dust lanes in nebulae.
    D. It allows us to best see the full extent of the crater rays of Tycho and Copernicus, two of the most prominent lunar craters.
    E. Moonlight cancels out the effects of light pollution.

31. Why do we have twilight?

    A. Sunlight scatters off air molecules high in the atmosphere.
    B. The sun is a disk not a point.
    C. Reflection of stray sunlight from interplanetary dust along the plane of the Ecliptic.
    D. Atoms high up in the atmosphere recombine and emit radiation at visible wavelengths.
    E. Twilight is a mental illusion perpetuated by romance novels.

32. Which statements about the Sun are true?

    A. To see the opposite face of the Sun fully, we have to wait until Earth has moved to the other side of its orbit.
    B. The hottest region of the Sun is its corona.
    C. The Sun is not an average star; it has far more mass than the most common main-sequence stars in the galaxy (class K & M red dwarves).
    D. The sun will reach a stage where its largely powered by fusion of carbon into heavier elements.
    E. The opposite face of the Sun is dark and emits no visible light.

33. Open star cluster A has a known distance of 400 pc and is believed to be around 1 billion years old. It is observed that the most luminous main-sequence members of open star cluster A have spectral classes of F. Looking through a telescope, I notice a red star (B) that appears to lie within A, and has a similar brightness as the main members of the cluster.

    Which of the following statements is most likely to be true?

    A. B is a main-sequence star located in cluster A.
    B. B is a red dwarf located in the background of cluster A.
    C. B is a red giant located in the foreground of cluster A.
    D. B cannot have a spectral class of O or B.
    E. B cannot be on the main-sequence.

34. A satellite appeared above the horizon while Mike is playing football at 08.00 pm (23 November 2015). Given that the orbital period of satellite is 18 hours, what time would the satellite return to the same position above Mike's horizon again? Assume everything lies on the equator.

    A. 24 November 2015 02.00 pm
    B. 24 November 2015 08.00 pm
    C. 25 November 2015 02.00 pm
    D. 25 November 2015 08.00 pm
    E. 26 November 2015 08.00 pm

35. An article suggests that for date X, the Moon will be visible after midnight in the constellation of Scorpius. Which of the following statements is most accurate?

    A. As Scorpius is in the southern half of the celestial sphere, this event cannot be seen anywhere in the Northern Hemisphere.
    B. "Midnight" must refer to Universal Coordinated Time.
    C. "Midnight" must refer to 00h 00m 00s in local sidereal time.
    D. The article is lying: the moon can never appear in the constellation of Scorpius.
    E. None of the statements above are true.

36. One day, a star rises at midnight. In 30 days, when will an astronomer observe the star rise, given that he stayed in the same location?

    A. 22:00
    B. 23:56
    C. 23:59
    D. 00:04
    E. 02:00

37. We do not see impact craters on the surface of Jupiter because:

    A. Jupiter's moons take all the hits from incoming meteors.
    B. Jupiter's gravitational field protects it from meteors.
    C. Jupiter has no visible solid surface on which craters can potentially form.
    D. Jupiter's magnetic field deflects meteors.
    E. Jupiter is too far away for our telescopes to resolve craters there.

38. The maximum angular resolution of a 14” Celestron telescope at λ = 500nm is:

    A. 0.25”
    B. 0.30”
    C. 0.35”
    D. 0.40”
    E. 0.45”

39. The amount of solar energy received by the Earth at a distance of 1 AU (Astronomical Unit) is 1380 Watts / m^2. The amount of solar energy received by the planet Mercury, given that the Mercury-Sun distance is currently at 0.39 AU is:

    A. 9027.98 Watt/m^2
    B. 9072.98 Watt/m^2
    C. 9272.59 Watt/m^2
    D. 9507.28 Watt/m^2
    E. 9752.89 Watt/m^2

40. A galaxy is observed at a distance of about 10 Mpc. It can be concluded that light from the galaxy originated approximately _____.

    A. 10000 years ago
    B. 32600 years ago
    C. 10 million years ago
    D. 13.7 billion years ago
    E. 32.6 million years ago

41. A star cluster in which the individual stars do not show a striking central concentration nor an orderly pattern or structure is called _____.

    A. a thin cluster
    B. an open cluster
    C. a random cluster
    D. a globular cluster
    E. a nebulous cluster

42. If two planets orbit a star with a ratio of the semi-major axis of the orbits of 2:5, what is the ratio of their orbital periods?

    A. 1 : 0.4
    B. 1 : 0.54
    C. 1 : 1.84
    D. 1 : 3.95
    E. 2 : 5

43. The average distance of Mars from the Sun is 1.52 AU. The largest separation angle between the Earth and the Sun when viewed from Mars is then…? Assume circular orbits.

    A. 11.41^{o}
    B. 14.41^{o}
    C. 33.34^{o}
    D. 41.14^{o}
    E. 44.41^{o}

44. Which of the following statement(s) about the moon is/are true?

    i. Due to lunar libration, we can see more than 90% of the lunar surface.
    ii. Neap tides occurs when the moon is at first and third quarter.
    iii. A synodic month is 27.3 days while a sidereal month is 29.5 days.
    iv. The distance between Earth and Moon is increasing while the Earth's spin is slowing down.
    v. Apogee is the closest approach of the Moon to Earth while Perigee is the furthest approach of the Moon to Earth.

    A. i and iv only
    B. i, ii and iv only
    C. All except iii
    D. All except iv
    E. None of the above

45. Polaris is the current North Pole Star. However, Vega used to be the North Pole Star back in 12,000 BCE. This is due to?

    A. Gravitational lensing
    B. Axial precession
    C. Recession of Earth's spin
    D. Doppler shift
    E. Stellar drift

46. Which of the following statements regarding stars is true?

    A. About 50% to 60% of the lifetime of small stars is spent in burning the helium and hydrogen out of the main sequence.
    B. The mass of a neutron star cannot exceed Chandrasekhar limit.
    C. During the red giant phase, helium in the core gets fused into carbon and other elements. This process generates a huge amount of energy, creating most of the carbon and nitrogen in the universe.
    D. When hydrogen gets exhausted in the hydrogen burning layer of a star, the core of a small star starts contracting. Its temperature increases and pressure rises like a degenerate electron gas. As a result, helium is ignited within the core.
    E. Stars with mass less than the mass of the Sun will have hydrogen, helium and possibly carbon involved in their phases of thermo-nuclear burning.

47. Before the Big Bang:

    A. The Universe was collapsing in a Big Crunch.
    B. We were in a multiverse filled in expanding and contracting Universes.
    C. A black hole had formed, which then created the Big Bang.
    D. We were in a sea of quantum fluctuations, out of which random events like the Big Bang could occur.
    E. We have no conclusive theory on what happened.

48. Despite the thousands of exoplanet candidates that we have found so far, very few exoplanets have been directly imaged. Which of the following statements is the biggest reason why this is the case?

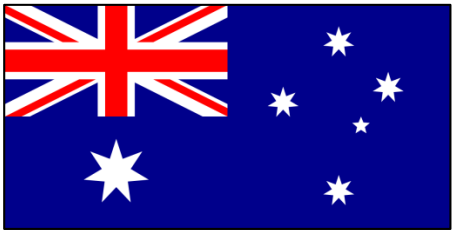
    A. Light from the host star overwhelms any light from the planet.
    B. Exoplanets have very low albedo, and thus have a very low luminosity in visible light
    C. Due to their low apparent brightness, extremely long exposure times are required.
    D. Their small angular size means they are too tiny to be detected at all.
    E. Interstellar extinction dims these planets beyond the threshold for direct imaging.

49. Large amounts of star formation are/were believed to occur:

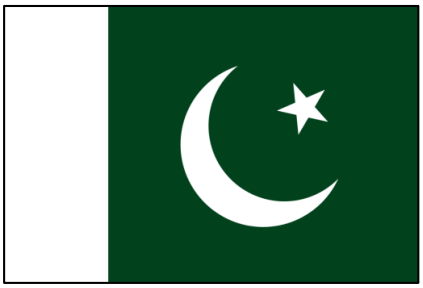
    A. When 2 elliptical galaxies collide and merge
    B. When a giant molecular cloud cools and collapses
    C. After the outflow of other newborn stars evaporates nearby dust clouds
    D. At the beginning of the Big Bang, immediately after Big Bang nucleosynthesis ended
    E. None of the statements above are true

50. Here are the flags of some countries/territories:

Flag of Alaska



Flag of Australia



Flag of Pakistan

Flag of Singapore

Which statement about the flags of these countries/territories is most likely to be astronomically accurate?

A. The Singapore flag contains a crescent moon because the Moon is always a waxing (or waning) crescent during National Day
B. The Pakistani flag commemorates Passover, in which Proxima Centauri passed between Earth and the Moon in AD 1379
C. The flag of Alaska contains the Big Dipper and the bright star Vega
D. The Australian flag prominently features the Diamond Cross in Carina
E. None of these statements are astronomically accurate in any way.

-The End-