AstroChallenge 2014
Multiple Choice (Senior)

instructions

- This booklet contains 50 questions and consists of 17 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 booklet.

- At the end of the paper, submit this paper together with your answer script and Formula Book.

- It is your responsibility to ensure that your answer script has been submitted properly.

1. In astrophotography, Quantum efficiency is _____.

   (a) a measure of how efficiency of quantum mechanics

   (b) a measure of the number of electrons being converted to light

   (c) the fraction of the energy from a star which is emitted as light

   (d) the fraction of incoming photons converted to photoelectrons

   (e) a nonsense term for a trick question

2. Is it true that young stars are further distributed from the galactic disk than older stars?

   (a) No. Stars form in interstellar clouds close to the plane of the disk but drift out over time due to interactions with other stars and molecular clouds.

   (b) Yes. Young stars have lighter elements in their cores and are more likely to drift out of the galactic disk over time.

   (c) Yes. Young stars form in interstellar clouds, which are further distributed from the galactic disk than dense older stars.

   (d) No. By the cosmological principle, the universe appears homogeneous from any and every point in space.

   (e) Insufficient data. The trend is not always clear.

Questions 3 to 8 require use of Table 1. All objects are assumed to be visible in Singapore skies (i.e. no blocked visibility) unless further stated.

Table 1

Object Name	R.A.	Dec.	Apparent Magnitude
M44	8 h 40 m 6.0 s	+19°59'00"	3.1
Suhail	9 h 07 m 59.7 s	-43°25'57.1"	2.2
M31	0 h 42 m 42.0 s	+41°16'00.0"	3.5
Spica	13 h 25 m 11.5 s	-11°09'41.3"	0.95
M57	18 h 53 m 36.0 s	+33°02'00.0"	9
Rigil Kent	14 h 39 m 31.9 s	-60°49'17.8"	3.7
M45	3 h 45 m 48.0 s	+24°22'00.0"	1.6
Persei	3 h 08 m 10.1 s	+40°57'20.3"	2.05
NGC2210	6 h 11 m 30.0 s	-69°06'00.0"	10.20
Orion Nebula	5 h 35 m 24.0 s	-5°27'00.0"	4.0
Capella	5 h 16 m 41.5 s	+45°59'46.6"	0.05
M8	18 h 03 m 48.0 s	-24°23'00.0"	5.8
NGC6809	19 h 40 m 0.0 s	-30°58'00.0"	7

3. On a certain day, the Sun sets in the West. As it does, Alhena (RA/DE: 6h37m42.7s/+162356.5) rises just above the horizon in the East. From the above list, what objects cannot be seen on this night of observation?

   (a) Orion Nebula, NGC2210 and Capella only

   (b) ==M57, M8 and NGC6809 only==

   (c) M44 only

   (d) M57, NGC2210 and NGC6809 only

   (e) All objects can be seen throughout the night

4. At midnight on this particular day, which objects will be close to the meridian?

   (a) M31 only

   (b) Capella, M31 and Persei only

   (c) M57, M8 and NGC6809 only

   (d) ==Orion Nebula, Capella and NGC2210 only==

   (e) Stars near the meridian cannot be seen in Singapore.

5. Therefore, what season (northern hemisphere) is this particular night in?

   (a) Season of Spring

   (b) ==Season of Summer==

   (c) Season of Autumn

   (d) Season of Winter

   (e) Season of Love

6. On another night, you decide to plan a public observation session on the NUS field. That evening, you notice that just after sunset, Suhail will be just visible over the Western horizon. Your public observation session lasts for 3 hours after sunset, at 7pm. Apart from Suhail, what other objects from the above list should you plan on observing?

   (a) You should plan to try and observe every object on the list.

   (b) ==NGC2210, M8, NGC6809, M57 and Orion Nebula only==

   (c) Every object with a magnitude more than 6 (naked eye limit).

   (d) Capella and M31 only

   (e) Spica, M57, M8, NGC6809, Rigil Kent only

7. One night, an astronomy club decided to conduct an overnight session. The telescope was set up, and observation begun at 7pm; the Sun and M44 were just setting. From the objects on the list, what is the smartest observation plan?

   (a) Observe objects in increasing DE, starting from +19° 59'00" onward.

   (b) ==Observe objects in increasing RA, starting from 8 h 40 m 6.0 s onward.==

   (c) Observe objects in decreasing RA, starting from 8 h 40 m 6.0 s onward.

   (d) Observe objects in decreasing DE, starting from +19° 59'00" onward.

   (e) It does not matter.

8. Despite the clear sky, the seeing that night was very bad after the first hour of observation. What should the club do?

   (a) Give up and use Stellarium indoors.

   (b) Observe objects in the Western portion of the sky.

   (c) Observe objects in the Eastern portion of the sky.

   (d) Observe objects closest to the zenith.

   (e) Continue observing, but slew from object to object faster.

9. Which of the following statements is true?

   (a) Ancient Greeks used Polaris as the guide for North;

   (b) Summer will always be around July in the Northern Hemisphere in the future;

   (c) The Earth is farthest from the Sun in July currently;

   (d) A sidereal day (23h56m) is shorter than a solar day (24h), thus a sidereal year is shorter than a tropical year;

   (e) Precession of the Earths rotational axis is solely due to the Moons gravity.

10. Which of the following statements about optics is **true**?

    (a) Comatic aberration is caused by focusing off-axis rays onto a plane using an optical system exhibiting field curvature.

    (b) With a parabolic mirror, incoming rays of light from distant objects are focused onto a plane perpendicular to the optical axis.

    (c) The catacaustic envelope of aberrated rays reflected off a spherical mirror is a cardioid.

    (d) In an astigmatic optical system, the medial focus is always found exactly halfway between the tangential and sagittal foci.

    (e) The Abbe sine condition holds only for small angular deviations from the optical axis.

11. Which of the following statements is incorrect?

    (a) Chromatic aberration occurs because the lens focuses light on a focal point that differs for different wavelengths.

    (b) Chromatic aberration causes blue wavelengths to have a longer focal length than the red wavelengths

    (c) Chromatic aberration does not occur in reflecting telescopes

    (d) Spherical aberration occurs because the mirror surface of reflecting telescopes does not reflect the incoming light toward the same focal point

    (e) Spherical aberration does not occur on a refractor telescope.

12. A star has an apparent magnitude of 0.18, a stellar parallax of 0.31" and a temperature of 5310 K. Calculate the luminosity of the star in terms of solar luminosities.

    (a) 10.9

    (b) 0.0917

    (c) 0.0117

    (d) 7.83

    (e) Insufficient data

13. Calculate the maximum Doppler shift of the hydrogen Hα emission line emitted from the outer edge of an accretion disc with radius 4.7×10^8 m around a star of 1.0 solar mass.

    (a) 4.06 nm

    (b) 40.6 nm

    (c) 0.583 nm

    (d) 5.83 nm

    (e) 1.16 nm

14. In the constellation Crux, the α, β, γ and δ stars are named in which order?

    (a) Clockwise

    (b) Anti-clockwise

    (c) Left to right, Top to bottom

    (d) Top to bottom, right to left

    (e) No particular order

15. Which of the following statements is correct?

    (a) Class O stars shows ionized Helium line and Titanium Oxide molecular bands.

    (b) Given the same spectral class, spectral lines of stars in the dwarf luminosity class are wider than those in the supergiant luminosity class

    (c) Given the same spectral class, spectral lines of stars in the supergiant luminosity class are wider than those in the dwarf luminosity class

    (d) The stellar spectrum only depends on the abundance of the element

    (e) The stellar spectrum only depends on the surface temperature

16. Which of the following is correct?

    (a) Spectral class shows us the temperature of the star but not the colour of the star

    (b) Two-colour diagrams can give us the overall relationship between the energy radiated by the star and the stars temperature

    (c) Two-colour diagrams can give us the overall relationship between the magnitude in the blue wavelength region and the magnitude in the red wavelength region

    (d) In a Hertzsprung-Russell Diagram, luminosity of M class stars is always higher than luminosity of G class stars

    (e) In a Hertzsprung-Russell Diagram, the luminosity of A class stars is always lower than the luminosity of G class stars

17. Which of the following types of stars are the biggest?

    (a) Blue supergiants

    (b) Red supergiants

    (c) Red giant

    (d) Blue Stragglers

    (e) White dwarfs

18. You notice that a celestial object in the sky with a fixed position has a fluctuating apparent magnitude of 3.9 ± 0.3 that has been observed for the past millennium. (Discount atmospheric effects and interference on Earth) Which of the following explanations can **NEVER** account for this possibility?

    (a) The object could be a Type I Cepheid variable star that varies in brightness over fixed time intervals.

    (b) The object could be a binary star system that varies in brightness depending on their position.

    (c) The object could be a nearby red dwarf with a massive planet orbiting it.

    (d) The object could be a relatively recent Type IIF supernova that collapses and expands periodically.

    (e) The object could be a semi-regular variable Star that varies in brightness with no fixed intervals.

19. Having observed the sunrise every day in the same location, an astronomer noticed that the azimuth of the sunrise point changes in the range of 90 during the year. What is the magnitude of the latitude of the observation place? (refraction and solar disk size can be neglected)

    (a) 90.0

    (b) 43.8

    (c) 55.8

    (d) 45.0

    (e) 78.3

20. The following events describe the Nebular Hypothesis regarding the formation of Solar Systems. Arrange them in chronological order.

   I A majority of the materials in the protoplanetary disk collapse into a dense central region known as the protostar.

   II Gravity causes debris in the protoplanetary disk to form planetesimals.

   III Conservation of angular momentum causes a Nebula to spin faster and eventually flatten into a disk.

   IV The protostar reach conditions of temperature and pressure to initiate hydrogen nuclear fusion to form a star. Planetesimals accrete more matter such as metals, silicates, ice, methane and ammonia to eventually form planets.

   V Materials left from the beginning of the universe or the supernovae of larger stars form a Nebula.

   (a) V, II, I, IV, III

   (b) III, II, I, IV, V

   (c) V, IV, III, II, I

   (d) V, I, II, III, IV

   (e) V, III, I, II, IV

21. A star has ecliptic coordinates $(\beta, \lambda) = (41°, 213°)$ and a parallax of 0.60 arcseconds. Calculate the amplitude of Apparent Brightness magnitude variation of the star due to revolution of the Earth around the sun [Hint : β is ecliptic latitude and λ is ecliptic longitude]

   (a) 4.144×10^{-6}

   (b) 2.513×10^{-6}

   (c) 4.767×10^{-6}

   (d) 5.297×10^{-6}

   (e) 1.322×10^{-6}

The following two questions make reference to Table 2, containing statistics from a binary star system, some of the which are missing.

Table 2

Property	Star A	Star B
Surface Temperature/ K	?	8500
Colour and Spectral Class	Orange, K	?
Wavelength of maximum emission (λ_{max})/nm	660	?

22. What is the estimated surface temperature of star A and the most likely spectral class and observed colour of star B? (all values to 2 s.f.)

    (a) 5000 K, Spectral class B, Deep Blue

    (b) 4200 °C, Spectral class G, Yellow

    (c) 4500 K, Spectral class A, Blue White

    (d) 4500 K, Spectral class M, Orange Red

    (e) 4200 K, Spectral class O, Bright Blue

23. Assuming both stars lie in the main sequence, refer to Figure 1 and the previous table for this question. Which of the following statements about the binary star system is false?
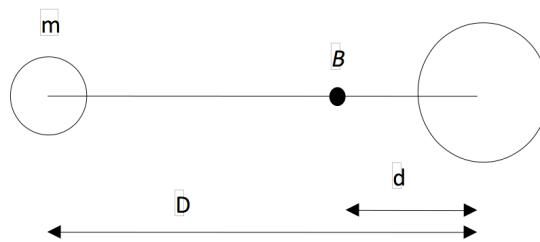

Figure 1

    (a) Star A is likely to be the less massive star of mass m and smaller in size compared to star B, of mass M.

    (b) The star of mass m has a lower surface temperature than the star of mass M.

    (c) The more massive star with a mass of M is likely to have a shorter life span compared to the smaller star with a mass of m.

    (d) The following equation, $d = \frac{mD}{m+M}$, describes the mathematical relationship between m, M, D and d.

    (e) The star with a mass of M will have a shorter orbital period about the Barycentre B due to the shorter distance (d) from the eclipse foci, while the star with a mass of m will have a longer orbital period.

24. Which of the following statements about various aspects of the Search for Extra-Terrestrial Intelligence (SETI) is accurate and true?

    (a) Rare Earth hypothesis – A probabilistic argument which is used to estimate the small number of active, intelligent extra-terrestrial civilizations capable of communication in our universe.

    (b) Fermi paradox – the apparent contradiction between high estimates of probabilities of existence of extra-terrestrial civilizations but humanity's lack of contact with, or evidence for, such civilizations.

    (c) Drake equation – A formula coined by Frank Drake to describe how emergence of complex multicellular, intelligence life on planets required an improbable combination of astrophysical and geological events and circumstances, which coincides with the low probability of such life.

    (d) Arecibo message – A color-coded binary code containing vital information regarding life on earth, encoding the 20 essential amino acids and the structure of DNA, signifying the first serious attempt by mankind to convey important information to extra-terrestrials.

    (e) Voyager Golden Record – a pair of gold-anodized aluminium plaques placed on board the probes Voyager 1 and Voyager 2, featuring nude figures of a human male and female along with symbols designed to provide information about the origin of the spacecraft and location of Earth.

25. Which of the following problems cannot be resolved within the Fission Theory regarding the formation of the Earths moon?

    (a) Why is the moons orbit inclined to earths rotation?

    (b) Why is the moons composition so similar to that of earth?

    (c) Why does the moon lack a substantial iron core?

    (d) Why is the moons mass only 1/81 that of earth?

    (e) Why does the moons surface have so many craters?

26. Which change in the appearance of a normal star is likely to occur when a massive object composed of WIMPs passes directly between you and the star?

    (a) No change

    (b) Star light dims momentarily because the massive object blocks the light.

    (c) The star brightens temporarily and becomes bluer.

    (d) The star brightens temporarily, with all colors brightening equally.

    (e) None of the above

27. Consider two telescopes which both have a focal length of 20 m. Telescope A has a primary mirror of diameter 10 m, and telescope B has a primary mirror of diameter 15 m. In order to obtain an image of reasonable quality, I require an exposure time of 5 minutes on telescope B. For how long must I expose the same sensor on telescope A to recover a comparable image?

   (a) 3.33 minutes

   (b) 4.33 minutes

   (c) 5 minutes

   (d) 8.66 minutes

   (e) 11.25 minutes

28. The annual meteor shower near November 17th is called the Leonids (*Leontids*, in Latin). Why are they named as such?

   (a) Because the comet Temple-Tuttle always appears in the constellation Leo at perihelion

   (b) Because all Leonids appear to move towards the constellation Leo

   (c) Because the sun is located at the constellation Leo on that time

   (d) Because they were first characterised by William Leontid in the 18th Century.

   (e) Because all Leonids appear to radiate from the constellation Leo

29. Given that the temperature difference between the day and night side of a planet depends on its atmospheres heat trapping ability, which of the following planets has the biggest temperature difference between day and night?

   (a) Jupiter

   (b) Mars

   (c) Earth

   (d) Neptune

   (e) Mercury

30. Which one of the following sentences about the asteroid belt is incorrect?

   (a) The asteroid belt is located between Mars and Jupiter.

   (b) The size and distribution of the asteroid belt has stabilized after the Late Heavy Bombardment and has undergone little change since then.

   (c) All rocks from asteroids in the asteroid belt match the composition of the solar nebula there.

   (d) More than 98% of asteroids are found within the asteroid belt.

   (e) Many asteroids in the asteroid belt are trapped in resonances with Jupiter

31. Under the heliocentric model of the solar system, when does retrograde motion of Jupiter occur?

    (a) before an opposition of Jupiter

    (b) when the earth and Jupiter are on opposite sides of the sun

    (c) when the earth is nearest the sun

    (d) when Jupiter is near conjunction

    (e) None of the above

32. Scientists have discovered a new incoming comet at a distance of 5 AU from the sun. What observation would be the most suggestive piece of evidence that the comet actually originates from another stellar system?

    (a) The coma of the comet has only trace amounts of water

    (b) The comets nucleus is extraordinarily large (approximately 50 km)

    (c) The isotopic ratio of deuterium relative to hydrogen is much higher than Earth or the Sun

    (d) The comets orbital eccentricity is 1.062

    (e) The comets orbit is almost perpendicular to the plane of the ecliptic.

33. Consider the following statements:

    I Lunar eclipses can occur at any time in the year

    II Solar eclipses can only occur when the Sun, moon and Earth are in syzygy

    III Lunar & solar eclipses will occur when the Moon is near its orbital nodes

    IV Only 2 solar eclipses and 2 lunar eclipses can occur every year.

    Which of the above statements are false?

    (a) I & IV

    (b) II, III & IV

    (c) I, III & IV

    (d) II & IV

    (e) I & II

34. Given the *current* orbits of the moon and planets and enough time, which of the following statements is true from the perspective of an observer on Earth?

    (a) It is possible for the Moon to occult the Andromeda Galaxy (R.A. 0h 42m, Dec. = +41° 16)

    (b) It is possible for the Moon to occult the LMC (R.A. 5h 23m, Dec. = -69° 45)

    (c) Mars always has a larger angular diameter than Jupiter

    (d) It is impossible for the Moon to occult multiple planets at the same time.

    (e) It is impossible for Mercury and Venus to simultaneously transit the Sun.

35. What is the shortest total time needed to transfer a space probe whose orbit is near Earth surface to Mars and transfer it back to earth again? [Assume that Earth and Mars have circular orbits with a radius of 1 AU and 1.52 AU]

   (a) 2.65 years

   (b) 1.87 years

   (c) 1.41 years

   (d) 1.00 years

   (e) 5.12 years

36. Which of the following statements is correct?

   (a) The Sun will be above the horizon for the shortest period of time during December at the South Pole

   (b) On 23$^{\text{rd}}$ of December at the North Pole, the maximum elevation angle of the sun measured from the horizon is 23.5 degrees

   (c) At the equator, the length of day and night are the same on 21$^{\text{st}}$ of March and 23$^{\text{rd}}$ of September.

   (d) At equator, the length of day and night are the same only on 21$^{\text{st}}$ of March

   (e) It is possible to observe Alpha Centauri from the North Pole.

37. Which of the following statements describing Asteroids in our Asteroid belt is true?

   I Ceres, a prominent dwarf planet, lies in the asteroid belt.

   II S-type (Silicaceous/Stony) or rocky asteroids are the most common and numerous, followed by the M-type (Metallic) and C-type (Carbon).

   III The assigned number of an asteroid is indicative of its size; for example 1-Ceres is the largest asteroid, followed by 2-Pallas, 3-Juno, etc.

   (a) I only

   (b) I and II only

   (c) II and III only

   (d) I and III only

   (e) I, II and III

38. Interstellar matter consists of gas and dust. The component which is most responsible for dimming starlight is dust. This is predominantly because

   (a) Dust is more abundant than gas

   (b) Dust and gas are equally abundant

   (c) Dust grains are larger than gas particles

   (d) Dust grains are about the size of the wavelength of visible light

   (e) Temperature of dust is cooler than temperature of gas

39. The following statements are all part of the definition of a planet as set by the International Astronomical Union (IAU) EXCEPT:

    (a) The planet must be a celestial body that is in orbit around our Sun or an extrasolar star.

    (b) It must possess sufficient mass for its own gravity to assume hydrostatic equilibrium.

    (c) The planet must not be a satellite.

    (d) It must have cleared the neighbourhood around its orbit.

    (e) All statements are correct.

40. The following diagrams show the position of the Galilean moons around Jupiter when viewed through a telescope at different times throughout human history. The largest object is Jupiter. Which of the following is the correct identity of the moon in question?
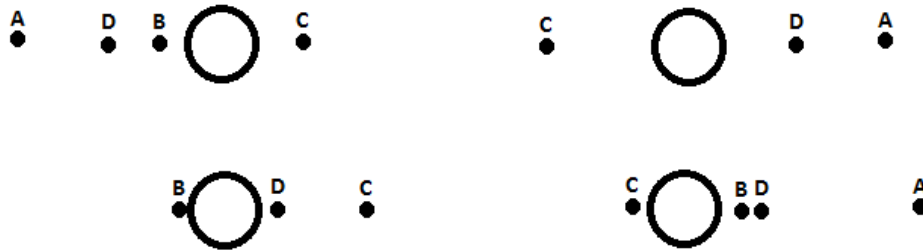
    (a) A- Ganymede B- Europa C- Calisto D- Io

    (b) A- Europa B-Io C- Calisto D- Ganymede

    (c) A- Calisto B- Ganymede C-Io D- Europa

    (d) A- Calisto B- Io C- Ganymede D-Europa

    (e) A and B are not Galilean moons because they cannot be observed at certain times.

41. Which of the following theories/observations invoke or supports the idea of an expanding universe?

    I The Geocentric universe, most famously proposed by Aristotle

    II The Heliocentric universe, first proposed by Nicolaus Copernicus

    III Cosmic Microwave Background Radiation (CMBR), discovered by American radio astronomers Arno Penzias and Robert Wilson

    IV Redshift in galaxies, observed by Edwin Hubble

    V The Tired Light theory, suggested by Fritz Zwicky

    VI The Steady State Universe, envisioned by Fred Hoyle, Hermann Bondi and Thomas Gold

    (a) II, IV and VI only

    (b) I, V and VI only

    (c) III, IV and VI only

    (d) IV and V only

    (e) II, III and IV only

42. Despite its initial popularity, the Steady State theory is now rejected by most cosmologists in favour of the Big Bang theory. Out of the following statements, which line of reasoning does NOT explain why this is the case?

    (a) If the Steady State theory was true, there would be no Cosmic Microwave Background radiation at all.

    (b) The universe is observed to be uniformly expanding at an accelerating rate

    (c) The night sky is dark, suggesting that the universe is finite in age

    (d) The relative abundance of light elements is close to what the Big Bang theory predicts

    (e) Far and faint galaxies have markedly different structure and higher star formation rates than nearby galaxies.

43. Between 1989 and 2009, radar stations detected 136 collisions between Earth and large meteors. The amount of energy released due to each collision is equivalent to the energy of 1000 tonnes of TNT. However, simulations suggest that **the number of large NEOs intersecting the Earths path in this interval is actually 10 times the number of detected collisions**. In other words, we have been exceedingly fortunate over this interval.

    Given this information, estimate the annual probability of a collision with a large meteor in terms of collisions per km^2 per year!

    (a) 1.33×10^0 collisions/km^2/year

    (b) 1.33×10^{-1} collisions/km^2/year

    (c) 1.33×10^{-4} collisions/km^2/year

    (d) 1.33×10^{-7} collisions/km^2/year

    (e) 1.33×10^{-10} collisions/km^2/year

44. Figure 2 shows an example of a Molniya orbit. Molniya orbits are highly inclined and elliptical orbits with a period of 12 hours. A satellite is sent up on this Molniya orbit, and has an apogee 39,300 km above the Earths surface. In contrast, a geostationary satellite has an orbit 35,786 km above the Earths surface.
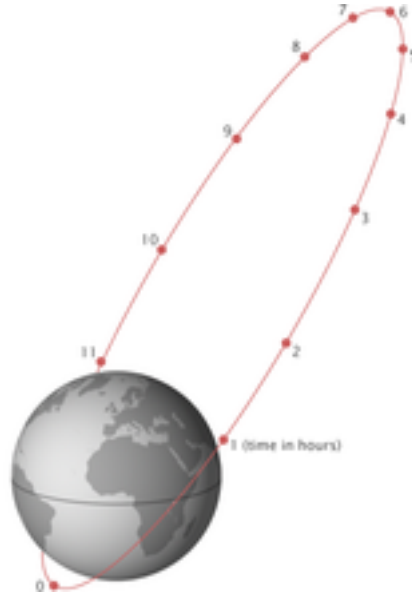

Figure 2

Which statement is true about a satellite in this Molniya orbit?

(a) The satellite always maintains the same right ascension relative to an observer on Earth.

(b) The semi-major axis of Molniya orbits are larger than geostationary satellites.

(c) More energy is required to launch the satellite into this orbit than a geostationary orbit

(d) Ignoring atmospheric refraction, Hendrik Island, Greenland (82N52W) would receive better coverage from this satellite than from a geostationary satellite.

(e) Albany, Australia (35S117E) would not be able to receive any signals from this satellite.

45. Two stars of different masses are orbiting their common centre of mass. We choose a coordinate system in which the centre of mass is stationary and is at the coordinate origin. Which of the following statements is **false**?

(a) Both stars orbit the centre of mass in ellipses that share one focus.

(b) The velocity vectors of the stars point in opposite directions.

(c) The position vectors of the stars point in opposite directions.

(d) The angular momentum vectors of the stars point in opposite directions.

(e) Both stars orbit the centre of mass in ellipses that have the same eccentricity.

46. In the absence of an atmosphere, incoming light waves from distant stars should have almost perfectly flat plane-shaped wavefronts. The presence of an atmosphere introduces irregular path differences to different parts of these wavefronts, resulting in optical distortion. Adaptive optics systems detect these distortions and correct them using a deformable mirror. Which of these techniques **cannot** be used in an adaptive optics system?

    (a) Detecting the slope of different parts of wavefronts from a reference light source

    (b) Detecting the curvature of different parts of wavefronts from a reference light source

    (c) Directly detecting the shape of wavefronts from a reference light source

    (d) Using light from a bright star as a reference light source describing how wavefronts from the patch of sky around it are distorted

    (e) Using light from a yellow laser beam scattered off the atmospheric sodium layer as a reference light source describing how wavefronts are distorted
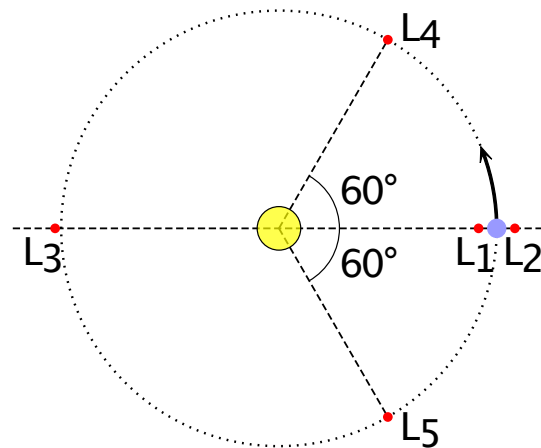

Figure 3

47. The Lagrange points for a two-body system (Figure 3) are locations where the gravitational pull from both bodies is exactly equal to the centripetal force required for a third, much smaller body to co-orbit in a fixed configuration. Which of them are **always** stable?

    (a) L1

    (b) L2

    (c) L3

    (d) L4/L5

    (e) None of the above

48. I pass light from a distant galaxy through a spectrograph to make observations. Which of the following statements is **false**?

   (a) By observing the positions of bright lines, I can determine its chemical composition.

   (b) By observing the positions of dark lines, I can determine its chemical composition.

   (c) By observing the positions of bright and dark lines, I can determine its speed relative to the Earth.

   (d) The bright and dark lines each correspond to exactly one wavelength of light.

   (e) Exactly one of the above statements is false.

49. If a star spectrum contains an absorption line at 802 nm, while the same spectral line occurs at 800 nm in the laboratory, the star must be:

   (a) Moving towards the source, at 750 km/s.

   (b) Moving away from the source, at 750 km/s.

   (c) Moving towards the source, at 750 m/s.

   (d) Moving away from the source, at 750 m/s.

   (e) Doing circular motion around an unseen companion, speed cannot be determined.

50. Diffraction spikes result when light from a distant star diffracts around the support struts for the secondary mirror in a telescope. Figure 4 illustrates what I would observe of a distant star through a given telescope configuration.

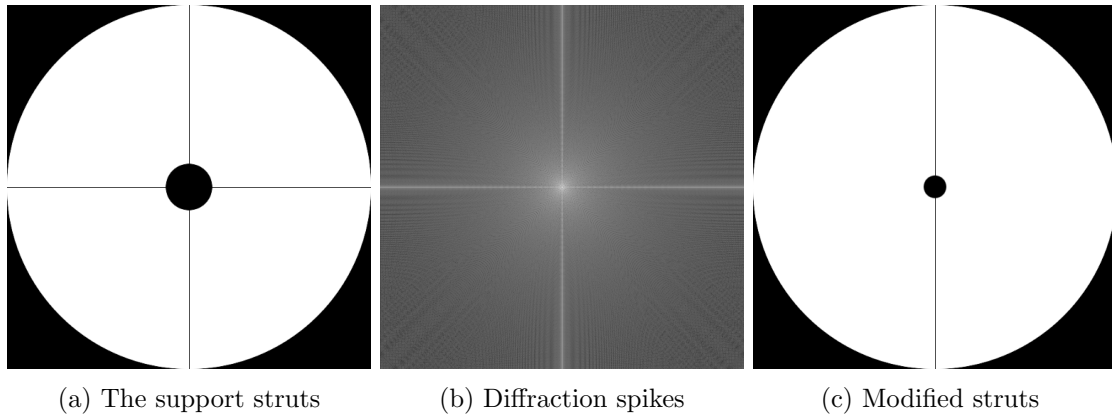(a) The support struts   (b) Diffraction spikes   (c) Modified struts

Figure 4

Suppose I were to reduce the size of the secondary mirror and remove one of the support struts (Figure 4c). Which of the following images most accurately describes what I would observe of a star?

(a)   (b)

(c)   (d)

(e) None of the given images are accurate in any way