AstroChallenge 2014
Multiple Choice (Junior)

INSTRUCTIONS

- This booklet contains 50 questions and consists of 16 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.

Use the following information to answer questions 1 to 5. A telescope and some equipment are given to some students. The specifications of the equipment are as follows:

Telescope		Eyepiece C	
Focal length	480 mm	Focal length	25 mm
Aperture	80 mm	Apparent field of view (AFOV)	50°
Eyepiece A		**Eyepiece D**	
Focal length	40 mm	Focal length	15 mm
Apparent field of view (AFOV)	70°	Apparent field of view (AFOV)	60°
Eyepiece B		**Eyepiece E**	
Focal length	32 mm	Focal length	5 mm
Apparent field of view (AFOV)	50°	Apparent field of view (AFOV)	60°

1. What is the f-number of the above telescope?
   (a) f/6
   (b) f/480:80
   (c) f/0.1667
   (d) f/80:480
   (e) Not enough information to calculate f ratio.
2. Which eyepiece gives the best exit pupil size?
   (a) A
   (b) B
   (c) C
   (d) D
   (e) E
3. A student wants to observe the Andromeda galaxy (about 178'), framing it as best as possible in the field of view. Which eyepiece would be best?
   (a) A
   (b) B
   (c) C
   (d) D
   (e) E

4. After observing Andromeda, the teacher wanted to look at the full Moon and insists on framing it entirely. He should _____ because _____.

   (a) increase magnification. the Moon is of similar angular size as Andromeda, but is too bright. This would reduce the brightness.

   (b) decrease magnification. the Moon is bigger than Andromeda.

   (c) increase magnification. the Moon is smaller than Andromeda.

   (d) keep magnification the same. the Moon is much brighter than Andromeda and might blind you.

   (e) Trick question. the full Moon is bright enough to see using just a telescope without an eyepiece. He should thus remove the eyepiece.

5. For the teacher to frame the entire moon, eyepiece _____ would be best

   (a) A

   (b) B

   (c) C

   (d) D

   (e) E

6. Black holes are interesting celestial bodies. Which of the following statements are false?

   I Black holes need not have very large masses.

   II Under existing theory, we can observe radiation from Black holes.

   III Black holes trap materials by huge gravitational force, as photons do not have any mass, they can escape the event horizon.

   IV Smaller Black holes evaporate at a faster rate.

   V Sirius A is likely to collapse into a black hole at the end of its life.

   (a) I, II.

   (b) III, IV, V.

   (c) III, V.

   (d) II,III,V.

   (e) I,V.

7. Which of the following statements are true? Astrophotography _____.

I is only for research

II can be performed using extreme wavelengths of light (X-ray, radio, etc.)

III need not be an expensive undertaking

IV can only be done at night

V involves both short and long camera exposures

(a) II, III, IV, V only

(b) I, III only

(c) II, III, and V only

(d) All of the above

(e) None of the above

8. Which of the following statements are true? Constellations are _____.

I groups of bright objects in the sky that can be joined by imaginary lines

II an area of the sky

III a group of stars in a certain pattern

IV now defined by the International Astronomical Union

V great kings of the past

(a) I and III only

(b) I, III and IV only

(c) II and IV only

(d) I, II, III and IV only

(e) All of the above

9. Which of the following in Figure 1 correctly matches the names of the solar system bodies to their relative sizes?

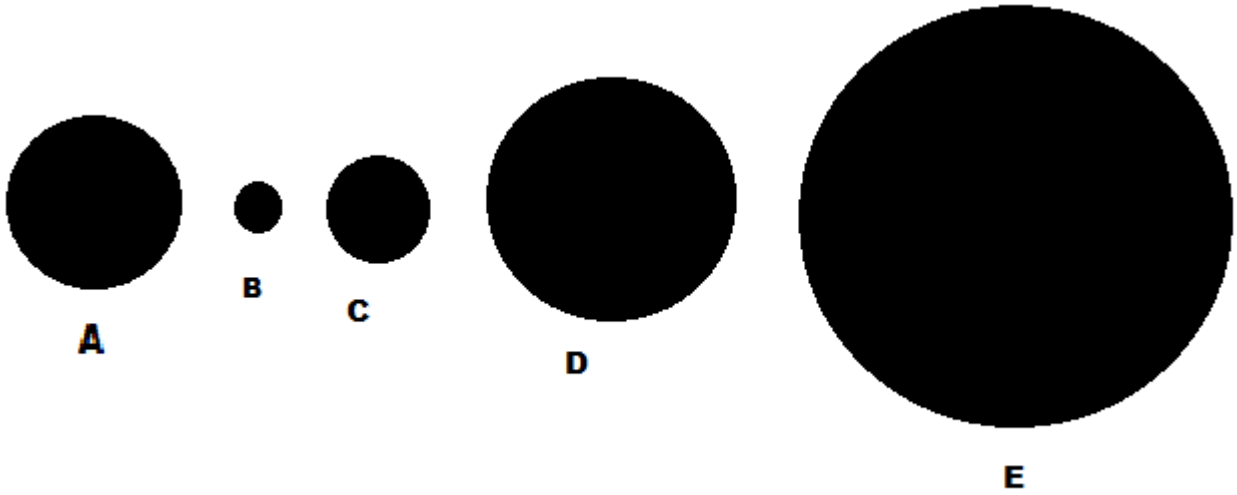


Figure 1

   (a) A-Mars, B-Ceres, C-Venus, D-Europa, E-Titan

   (b) A-Titan, B-Europa, C-Titan, D-Venus, E-Mars

   (c) A-Ceres, B- Europa, C-Titan, D-Mars, E-Venus

   (d) A-Titan, B-Ceres, C-Europa, D-Mars, E-Venus

   (e) None of the above

10. Aberrations are caused by different reasons, some are due to the lens while others are due to the intrinsic nature of light. Which of the following changes cannot reduce the relevant type of aberration?

   (a) Using monochromatic light to reduce chromatic aberration.

   (b) Increasing the acceptance angle to reduce spherical aberration.

   (c) Change lens to reduce astigmatism.

   (d) Decrease diameter of lens to reduce spherical aberration.

   (e) Increase focal length to reduce spherical aberration.

11. The Schmidt-Cassegrain telescope belongs to which category of telescope?

   (a) Catadioptric telescope

   (b) Reflecting telescope

   (c) Radio telescope

   (d) Refracting telescope

   (e) Spectroscope

12. In the northern hemisphere, what direction do most stars appear to move across the night sky?

    (a) East to west

    (b) West to east

    (c) Direction varies depending on the altitude of the observer

    (d) Direction varies depending on the seasons

    (e) This is a trick question. Stars do not appear to move across the night sky.

13. Consider a visual binary system with a parallax of 0.4 arcsec, orbital period of 80 years and maximum orbital separation of 0.0125 arcsec. What is the total mass of the system? (Assume a circular orbit.)

    (a) 2.39×10^{31} kg

    (b) 9.50×10^{21} kg

    (c) 3.03×10^{21} kg

    (d) 7.63×10^{30} kg

    (e) 3.58×10^{31} kg

14. Which of the following statements is true?

    (a) Stars rise 4 minutes earlier each day

    (b) Stars rise 10 minutes earlier each day

    (c) Stars rise 4 minutes later each day

    (d) Stars rise 10 minutes later each day

    (e) Stars rise the same time each day.

15. An astronomy society bought a telescope recently. Its parameters are listed below:

Aperture	120mm
Focal length of eyepiece	60mm
Focal length of object	1500mm

    What is the magnification of this telescope?

    (a) 2

    (b) 12.5

    (c) 25

    (d) 750

    (e) 72

16. Which of the following telescopes must be located in space in order to function?

    (a) Large Binocular Telescope

    (b) Gran Telescopio Canarias

    (c) Arecibo Observatory

    (d) CDK Telescope

    (e) Chandra X-ray Observatory

17. Assume that you have normal vision. Which option listed below contains stars/objects that all cannot be seen with the naked eye?

    (a) Mercury, Uranus, Neptune

    (b) Vega, Altair, Deneb

    (c) Polaris, Altair, Mercury

    (d) Pluto, Uranus, Proxima Centauri

    (e) El Nath, V838 Monocerotis and Shaula

18. One day, a group of astronomers went to Tioman. The leader said very excitedly, 'The seeing is very good tonight. I can see so many Messier objects with my telescope. If you find them tell where you find hor.' As the night went on, everyone kept answering and alerting the others of their latest find. However, one of them suddenly shouted 'Walau eh I confused the object and constellation just now.' Who is this unlucky guy?

    (a) 'Wah I saw the Orion Nebula, M42 in Orion!'

    (b) 'Oh I found one. The Lagoon Nebula, M8 in Sagittarius!'

    (c) 'I saw the Ptolemy Cluster, M7 in the Great Bear! People come look it!'

    (d) 'The Ring Nebula, M57 in Lyra is very beautiful one!'

    (e) 'The Beehive cluster, M44 in Cancer is visible tonight!'

19. A sungrazing comet of mass 7×10^{15} kg has a perihelion of 0.01 AU The gravitational force between the Sun and the comet at perihelion is approximately _____. For comparison, the gravitational force between the Sun and Jupiter at perihelion is 4.59×10^{23} N.

    Given these numbers, if comets can cause CMEs, we should be extremely worried about Earth bound CMEs when Jupiter is in _____! Thankfully for us, we dont observe this, which means we have nothing to fear from sungrazing comets.

    (a) 4.13×10^{17} N, conjunction

    (b) 4.13×10^{23} N, conjunction

    (c) 4.13×10^{17} N, opposition

    (d) 4.13×10^{23} N, opposition

    (e) 4.13×10^{19} N, greatest western elongation

20. Which of the following observations can be explained ONLY by invoking Einsteins theory of General Relativity AND cannot be accounted for by classical physics?

    (a) The orbits of the planets exhibit precession over time.

    (b) The period of two neutron stars orbiting each other has been observed to be decreasing at an accelerating rate.

    (c) By observing stellar motions in the galactic core, we have found evidence for black holes

    (d) The rotation curve of spiral galaxies flattens out after a certain distance from the galactic core.

    (e) The predicted positions of long period comets were often observed to be slightly off in the 1800s

21. 5 telescopes with a focal length of 1000 mm and equipped with sensors are simultaneously aimed at the same area of the night sky, and are then set to take an image. Which of these will gather the most light? Assume that everything else (sensor efficiency, noise etc.) is equal

    (a) A telescope with a 5 inch aperture and exposure time of 10 s

    (b) A telescope with a 3.5 inch aperture and exposure time of 15 s

    (c) A telescope with a 4 inch aperture and exposure time of 13 s

    (d) A telescope with a 6 inch aperture and exposure time of 6 s

    (e) A telescope with a 4.5 inch aperture and exposure time of 12 s

22. One day, John observed the full moon using a refracting telescope. Suddenly, a small fly stepped its foot on the objective lens. What will happen to the full moon image observed by John?

    (a) The moon image will have a foot in the middle

    (b) The brightness of the moon decreases

    (c) John cannot observe the moon at all

    (d) John can observe both the fly (magnified immensely) and the moon

    (e) Nothing will happen and John would observe the same moon image

23. Compared to Jupiter and Saturn, why does Neptune have very little hydrogen in its core?

    (a) The statement is false.

    (b) Neptune was large enough to accumulate hydrogen, but the core has since fused to helium under its own weight.

    (c) The other gas planets are more massive than Neptune, and thus accumulated most of the hydrogen in the early solar system.

    (d) The solar wind was strong enough to blow most of the hydrogen out of the early solar system by the time of Neptunes formation.

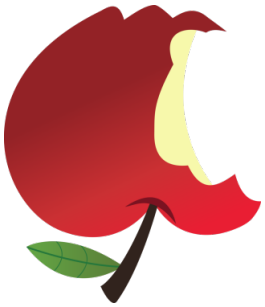
    (e) Hydrogen is a light element and over time it differentiated into a layer on Neptunes atmosphere where heavier elements sank into its core.

24. Figure 2 shows a very distant object as would be seen by a nearby observer.

Figure 2

Which of the following shows the image as seen through a Schmidt-Cassegrain telescope with a star diagonal?

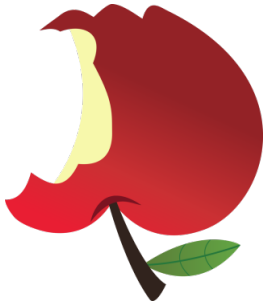
(a)



(b)

(c)

(d)



(e)

25. In Singapore this year, the Vernal Equinox is expected to occur around _____ while the Winter Solstice is expected to occur around _____.

    (a) January, September

    (b) March, December

    (c) August, November

    (d) June, October

    (e) December, July

26. Which of the following deep-sky objects could have been classified as Messier objects?

    I Comets

    II Diffuse nebulae

    III Planetary nebulae

    IV Stars (visual doubles and asterisms)

    V Open clusters

    VI Globular clusters

    VII Galaxies

    (a) I only

    (b) II, III, V, VI only

    (c) II, V, VI, VII only

    (d) I, II, IV, V, VII only

    (e) II, III, IV, V, VI, and VII only

27. Which of the following statements about prominent stars and asterisms in the night sky is true?

    (a) The alpha star is always the brightest star in the constellation.

    (b) In Singapore, it is only possible to observe Polaris (Alpha Ursae Minoris, or the North Star) approximately near the zenith during winter.

    (c) Betelgeuse, Aldebaran, Capella, Castor, Procyon, and Sirius make up the perimeter of the well-known asterism, the Winter Hexagon.

    (d) Draw a line from Regulus (the alpha star of Leo) to Spica (the alpha star of Virgo), and you will obtain a line that approximates the ecliptic.

    (e) The bright stars of Centaurus form the familiar Teapot Asterism, with δ, ε, ζ and ϕ Cen forming the body of the pot, λ Cen the point of the lid, γ Cen the tip of the spout, and σ, τ Cen the handle.

28. Which of the following statements is incorrect?

    (a) O spectral class stars shows strong continuous ultraviolet spectrum and ionized Helium line.

    (b) Hydrogen Balmer line appears stronger in A class spectral class

    (c) Metal lines appears in the F class stars spectrum

    (d) M class stars show a spectrum of molecular bands

    (e) It is possible to observe Titanium Oxide bands and ionized Helium lines in one spectrum.

29. Which of the following statements is incorrect?

    (a) Emission line in a stellar spectrum shows us that the star possesses a gas envelope

    (b) Wolf-Rayet stars are O class stars with broad emission lines

    (c) Broad emission lines in a spectrum suggests that the corresponding gas envelope is moving with high velocity

    (d) H-II region (ionized Hydrogen) gives an emission spectrum

    (e) Emission lines are caused by electrons transitioning from a lower energy level to a higher energy level causes

30. If two stars have the same size but different temperatures, the cooler star has which of the following characteristics?

    (a) Bluer, brighter

    (b) Redder, brighter

    (c) Bluer, fainter

    (d) Redder, fainter

    (e) Bluer, same brightness

31. The Hertzsprung-Russell diagram is a meaningful plot of stars, showing the relationship between stars spectral class / effective temperature and _____.

    (a) Luminosity

    (b) Apparent magnitude

    (c) Mass

    (d) Radius

    (e) Colour

32. A star of absolute magnitude 0.50 has an apparent magnitude of 4.50. The following statements are all incorrect, except for:

    (a) If the star had an apparent magnitude of 0.50 instead, it would be exactly 1 parsec away.

    (b) The star is approximately 63.1 parsecs away in reality.

    (c) If the star had an apparent magnitude of 5.50 instead, it is expected to be closer to us.

    (d) The star is dimmer than our Sun in terms of absolute magnitude.

    (e) The star is 9 times dimmer than it actually should have been due to distance.

33. The Sun is the closest star to our planet and the most familiar object in the daytime. All of the following facts about the Sun are correct except:

    (a) The Sun is a main sequence star of spectral class G2V.

    (b) The proton-proton chain is the main process by which the Sun fuses hydrogen into helium.

    (c) Sunspots, as a result of intense magnetic activity inhibiting convection, are actually cooler than the mean surface temperature of the Sun.

    (d) The Sun is in a state of hydrostatic equilibrium.

    (e) At the end of the Suns lifetime, it will undergo a supernova and become a neutron star.

34. _____ paradox implies that the universe, if _____, cannot be _____.

    (a) Olbers. static. infinite

    (b) Albers. expanding. infinite

    (c) Olbers. expanding. infinite

    (d) Albers. static. finite

    (e) Olbers. expanding. finite

35. Which of following regarding the planet Venus is false?

    (a) Venus is the brightest planet in the night sky.

    (b) To the observer, Venus appears brighter than Sirius, the brightest star in the night sky

    (c) Venus is always found fairly close to the Sun in the sky

    (d) Venus is often known as the morning star, or the evening star

    (e) Venus cannot be seen from the north pole.

36. Assuming we are in the Northern Hemisphere, which of the following statements is true?

    (a) At summer solstice, the Sun is at its northernmost point around the ecliptic, therefore it is highest in the sky.

    (b) At summer solstice, the Earth's South Pole points most nearly toward the Sun

    (c) At winter solstice, although the day is shortest, the Sun is highest in the sky.

    (d) At winter solstice, Earth's axis is perpendicular to the line joining Earth and the Sun.

    (e) The Sun passes through the celestial equator at Vernal equinox, which is around September 21.

37. Which one of the following sentences about solar eclipses is incorrect?

    (a) The observed temperature of the solar corona is higher than the photosphere during a solar eclipse.

    (b) The first photo of solar prominences in history was taken during a solar eclipse.

    (c) A long exposure photo is required to take a photo of the moon eclipsing the sun during total eclipse.

    (d) Up to 3 solar eclipses can happen in a year.

    (e) It is possible for a solar eclipse on a certain date to start off as annular and end as a total eclipse.

38. Why are the atmospheres of terrestrial planets devoid of free hydrogen and helium while the giant planets are composed mainly of these? Select the most appropriate reason

    (a) Terrestrial planets have a higher surface Temperature

    (b) Terrestrial planets have higher g

    (c) Hydrogen reacts with oxygen to give water on terrestrial planets

    (d) Terrestrial planets have lower period of rotation

    (e) None of the above

39. Iapetus is tidally locked to Saturn, and its leading hemisphere is dark (named Cassini Regio) while the trailing hemisphere is bright (named Roncevaux and Saragossa Terra). The bright material is believed to be predominantly ice. Little is known about the composition of this dark material, other than the fact that it is a very thin layer (10-30 cm) that coats the surface of Cassini Regio. This explains why Iapetus is much easier to observe from Earth when it is on the western side of Saturn than on the eastern side.

    Which of these hypotheses is the most plausible explanation for the weird geology of Iapetus?

    (a) Ices from micrometeoroids was preferentially deposited on Roncevaux and Saragossa Terra over time, coating them white.

    (b) Ice particles from Enceladus were preferentially deposited on Roncevaux and Saragossa Terra, while darker material from the outer E and Phoebe ring ended up on Cassini Regio.

    (c) Iapetus once had a ring system rich in ices. The ring system eventually spiralled inwards due to orbital interactions between it and other moons in the Saturnian system, coating Roncevaux and Saragossa Terra with ices.

    (d) Iapetus experienced thermal runaway due to its long days and nights. Initially darker regions became warmer and lost more ices, causing these regions to darken further and absorb even more sunlight. Meanwhile, initially brighter regions allowed ices to condense, increasing their albedo and reducing their temperatures further.

    (e) The orbit of Iapetus is highly unstable and evolves quickly. Several million years ago, Iapetus once had an orbit that passed through the Saturnian ring system. As the moon constantly ploughed through the ice rich rings, Roncevaux and Saragossa Terra were impacted by ice rich particles in the rings, coating them white and hence explaining the colour difference.

40. A circumpolar star cuts the meridian line at point A and point B whose altitude are 12 degrees and 55 degrees respectively (measured from the north cardinal point). Determine the declination of the star (δ) and the latitude of the observer (ϕ).

    (a) δ = 33.5 degrees, ϕ = 68.5 degrees

    (b) δ = -68.5 degrees, ϕ = -33.5 degrees

    (c) δ = -33.5 degrees, ϕ = -68.5 degrees

    (d) δ = -33.5 degrees, ϕ = -68.5 degrees

    (e) δ = 68.5 degrees, ϕ = 33.5 degrees

41. The “Supermoon” phenomenon happens when the

    (a) Full moon is at perigee

    (b) Full moon is at apogee

    (c) New moon is at perigee

    (d) New moon is at apogee

    (e) 1st quarter moon is at perigee

42. The person in the Figure 4 is located at the equator. Which is the position of the sun at noon during the summer solstice?

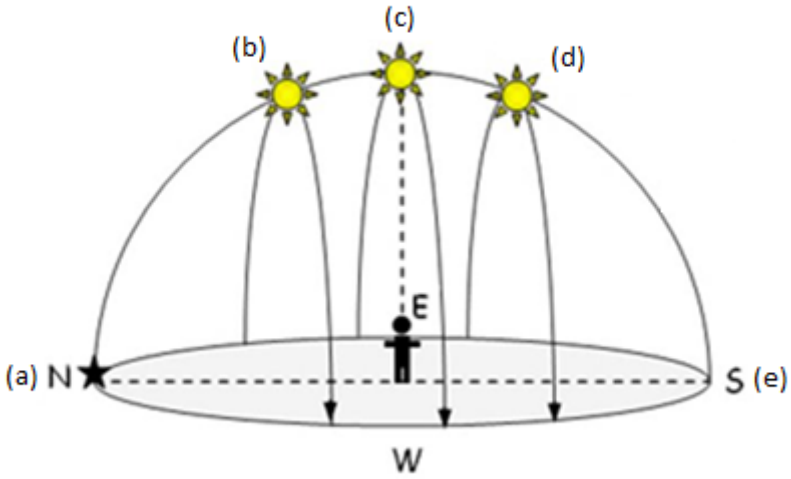


Figure 4

43. Which of the following statements is an inaccurate description of the natural satellite in question?

    (a) Io – one of the 4 moons first observed by Galileo Galilei orbiting Jupiter, it is the closest of the Galilean moons to Jupiter. As a result of tidal heating due to friction in the moons interior, it is the most volcanically active object in the solar system that constantly spews sulfur and sulfur dioxide gas.

    (b) Titan – The largest known satellite orbiting a planet in our solar system, this moon of Saturn possesses a thick atmosphere of mostly Methane, followed by Nitrogen and other gases.

    (c) Enceladus – The 6^{th} largest moon of Saturn, this satellite is one of the few which has a prospective underwater ocean beneath its icy surface as cryo-volcanoes on it emit jets of water and ice.

    (d) Titania and Oberon – The largest and second largest of the moons of Uranus, they are named after the queen and king of the fairies respectively after Shakespeare's 'A Midsummer Night's Dream.'

    (e) Triton – The largest moon of the planet Neptune, it is the only large moon in the Solar System with a retrograde orbit (opposite to its planet's rotation). This satellite is believed to have originated from the Kuiper belt due to its similarities in composition with dwarf planet Pluto.

44. Mass accretion is the process through which a gravitating body grows in mass by accumulating external matter. This process releases gravitational potential energy through radiation, termed accretion luminosity. This is in accordance with what law? Thus, if the Sun today was powered by accretion, estimate the mass accretion rate required to sustain its present luminosity.

    (a) Second Law of Thermodynamics, 2.01×10^{15} kg s^{-1}

    (b) Conservation of Mass-Energy, 3.01×10^{18} kg s^{-1}

    (c) Hubble Law, 2.01×10^{15} kg s^{-1}

    (d) Conservation of Mass-Energy, 2.01×10^{15} kg s^{-1}

    (e) Hubble Law, 3.01×10^{18} kg s^{-1}

45. Dark matter is estimated to form a significant fraction of the universe, yet remains poorly understood. Which of these statements about dark matter is believed to be true?

    (a) The cosmic microwave background is comprised of electromagnetic radiation emitted by hot dark matter in the early ages of the Universe.

    (b) Neutrinos are a possible component of cold dark matter

    (c) Massive Compact Halo Objects (MACHOs) are hot stellar remnants that could make up hot dark matter.

    (d) The clumpiness of the universe today despite its initial smoothness (as seen by the CMBR) suggests that most dark matter is in the form of cold dark matter.

    (e) Dark matter can be detected by how it absorbs light when light passes through it

46. Normally, people use H-α filters to observe sunspots. What does the letter H represent in this case?

    (a) Coating type

    (b) Hydrogen

    (c) High level series - advanced

    (d) Brand name of this filter

    (e) The 8th filter in the α series.

47. A body in the solar system has an aphelion of 2.4 AU and eccentricity 0.35. Calculate its orbital period, and thus categorise it accurately.

    (a) 1.19×10^7 s, main-belt asteroid

    (b) 1.19×10^7 s, Trans-Neptunian Object

    (c) 7.48×10^7 s, main-belt asteroid

    (d) 7.48×10^7 s, Trans-Neptunian Object

    (e) 7.48×10^7 s, Oort Cloud object

48. Which of the following changes would leave the orbital speed of the Earth unchanged?

    (a) If gravitational constant doubles.

    (b) If mass of Earth and Sun both increase by 9 times.

    (c) Tripling the semi-major axis of Earth, while increasing the solar mass by 9 times.

    (d) If mass of Sun doubles, while the gravitational constant is halved.

    (e) If mass of Sun triples, while decreasing the semi-major axis of Earth by 6 times.

49. A telescope is designed to be precisely calibrated for a specific, narrow band of infrared radiation, with all other wavelengths filtered out. Which of the following statements is **false**?

    (a) The detector used in the telescope must be kept very cold (usually, cooled with liquid nitrogen), because warm objects emit infrared radiation in a continuous spectrum.

    (b) The wavelength band must be carefully chosen, because the atmosphere itself emits infrared radiation in a continuous spectrum.

    (c) Lenses cannot be used because they will introduce chromatic aberration. Curved mirrors must be used to focus light instead.

    (d) Assuming that observing conditions are diffraction-limited and this telescope operates alone, the resolution of images captured by this telescope will be worse than one captured in visible light.

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

50. We can derive useful information from spectral lines of starlight. Which of the following relationship however is incorrect?

    (a) Obtain temperature from peak frequency.

    (b) Obtain composition from lines present.

    (c) Obtain composition from line width.

    (d) Obtain rotation speed from line width.

    (e) Obtain temperature from line intensity.