USAAAO 2016 – First Round Test and Key

1. All RR Lyrae variables have an absolute magnitude M of approximately 0.75. If an RR Lyrae star is observed with an apparent magnitude of 16.0, what is the distance to the star in kpc?
   a. 11.2 kpc
   b. 17.6 kpc
   c. 27.3 kpc
   d. 36.5 kpc
   e. 47.7 kpc

2. If the closest distance from a planet to its host star is 1.50 AU and its farthest distance from its host star is 4.50 AU, what is the area that this planet sweeps out over the course of a full orbit (in AU2)?
   a. 6.00π
   b. 3.50π
   c. 1.50π
   d. 6.75π
   e. 4.50π

3. A star exhibits periodic variations in brightness suggestive of a transiting companion. If the minimum stellar flux is 98.2% of the uneclipsed flux, what is the radius of the companion, in stellar radii, assuming the companion is not emitting?
   a. 0.018 stellar radii
   b. 0.134 stellar radii
   c. 0.268 stellar radii
   d. 0.974 stellar radii
   e. 0.982 stellar radii

4. Suppose you are on the surface of the Moon, and you want to launch an object into an elliptic orbit with a perilune of 1 lunar radius and apolune of 7 lunar radii. Given that the moon has a mass of $7.44*10^{22}$ kg and a radius of $1.74*10^3$ km, with what speed will you have to launch the object?
   a. 1.69 km/s
   b. 2.06 km/s
   c. 2.23 km/s
   d. 3.38 km/s
   e. 4.67 km/s

5. Estimate the minimum mass of a galaxy with a radius of 40,000 ly if stars at the edge of the galaxy orbit with a velocity of 50 km/s. Assume there is no dark matter in the galaxy. Answers are given in solar masses, with 1 solar mass = 1.99*1030 kg.
- a. 6.87*10^8
- b. 3.57*10^9
- c. 4.21*10^11
- d. 9.69*10^12
- e. 4.37*10^13

6. Estimate the mass of an old globular cluster if the escape velocity at the edge of the cluster is 8.5 km/s. The cluster is made up of red stars that are all around ½ of the mass of the sun. The cluster has a radius of 100 pc. Answers are given in solar masses.
- a. 1.2*10^4
- b. 6.8*10^4
- c. 3.1*10^5
- d. 5.6*10^5
- e. 8.4*10^5

7. What delta V must an earth orbiting spacecraft apply to transfer from a 200 km parking orbit to a transfer orbit with an apogee 35,786 km above the earth's surface? (The earth has a mass of 5.972*10^24 and a radius of 6371 km)
- a. 2331 m/s
- b. 2441 m/s
- c. 2543 m/s
- d. 2778 m/s
- e. 2846 m/s

8. Suppose a probe has a velocity of 20 km/s when it's 100 AU away from the Sun. What type of orbit is the probe on? The Sun has a mass of 1.99*1030 kg.
- a. Hyperbolic
- b. Parabolic
- c. Elliptic
- d. All of the above
- e. None of the above

9. Phobos orbits around 9,376 km away from the center of its host planet, Mars, and has an orbital period of 8 hours. What is the centripetal acceleration of Phobos due to Mars' gravitational pull? The mass of Mars is 6.39*1023 kg.
- a. 0.011 m/s^2
- b. 0.256 m/s^2
- c. 0.446 m/s^2

d. 0.657 m/s^2

e. 0.781 m/s^2

10. Mercury's orbit around the Sun has a semimajor axis of 0.387 AU. Knowing that the mass of the Sun is 1.99*1030 kg and assuming the mass of Mercury is negligible, what is Mercury's orbital speed when it's 0.34 AU away from the Sun in its orbit?

    a. 18 km/s

    b. 37 km/s

    c. 54 km/s

    d. 63 km/s

    e. 71 km/s

11. Mercury's orbit has a semimajor axis of 0.387 AU. What would be the maximum angular separation between Mercury and the Sun as seen from Venus? Venus's orbit has a semimajor axis of 0.719 AU. Assume both Mercury and Venus have perfectly circular orbits.

    a. 15.5°

    b. 28.2°

    c. 32.6°

    d. 42.9°

    e. 57.4°

12. A geostationary satellite orbits Earth so that it appears at all times to be at the Zenith as viewed from a fixed point somewhere on Earth's equator. Which of the following correctly describes the satellite's position on the celestial sphere?

    a. The satellite moves to the East along the celestial equator, traversing it once every sidereal day.

    b. The satellite remains stationary at a point on the celestial equator.

    c. The satellite moves to the West along the celestial equator, traversing it once every sidereal day.

    d. The satellite remains stationary at one of the celestial poles.

13. What would be the angular size of the sun as seen from Mars in arcminutes? Assume Mars orbits at a distance of 1.5 AU. (1 AU = 1.496*10^8 km, and the radius of the sun is 695,700 km)

    a. 0.178'

    b. 10.7'

    c. 16.0'

    d. 21.3'

    e. 32.0'

14. Only some stars rise (cross the horizon from below) due East (at Azimuth 90°). For an observer at Latitude 37°, Longitude 23°, these stars would be:

a. Stars at Declination 37°
b. Stars at Declination 23°
c. The answer will change throughout the year
d. Stars at Declination 0°

15. On March 3, 2012, Mars experienced retrograde motion. The configuration of the Sun, Mars, and Earth that led to retrograde motion repeats periodically. Given that Mars orbits the Sun once every 1.88 years, on which of these dates would you expect Mars to exhibit retrograde motion again?

a. November 27, 2013
b. August 20, 2012
c. April 22, 2014
d. June 13, 2015

16. Suppose there are two main-sequence stars, A and B. Star A has a temperature of 10,000 K, while Star B has a temperature of 5,700 K. The ratio of the radii of Star A to Star B is 3 to 2. What is the difference in absolute magnitudes between the two stars (absolute magnitude of Star B minus the absolute magnitude of Star A)?
a. 2.89
b. 3.32
c. 3.67
d. 4.32
e. 4.75

17. An active galactic nucleus is observed to produce a hydrogen emission line at 687.2 nm. The rest wavelength of this hydrogen emission line is 121.6 nm. What is its recessional velocity relative to us, in km/s?
a. 1.40*10^5 km/s
b. 2.14*10^5 km/s
c. 2.57*10^5 km/s
d. 2.82*10^5 km/s
e. 3.00*10^5 km/s

18. A planet is 1.3 AU from its host star. The host star has a luminosity of 2.41*1026 W. What is the radiant flux that the planet receives right above its atmosphere? 1 AU = 1.496*108 km.
a. 3.2*10^3 W/m^2
b. 4.0*10^3 W/m^2
c. 4.7*10^3 W/m^2
d. 5.1*10^3 W/m^2
e. 5.5*10^3 W/m^2

19. Suppose the absolute magnitude of a star is 3.25. What would its apparent magnitude be as seen from a planet orbiting the star at a distance of 0.670 AU? 1 AU = 1.496*1011 m, and 1 pc = 3.0856*1016 m.

    a. -29.2
    b. -28.6
    c. -28.3
    d. -27.5
    e. -26.9

20. Which of these is the correct sequence of events in the Universe, from earliest to latest?

    a. Dark energy dominated era, Inflation, Nucleosynthesis, Recombination
    b. Nucleosynthesis, Recombination, Dark energy dominated era, Inflation
    c. Inflation, Dark energy dominated era, Recombination, Nucleosynthesis
    d. Inflation, Nucleosynthesis, Recombination, Dark energy dominated era
    e. Recombination, Dark energy dominated era, Inflation, Nucleosynthesis

21. Suppose a star has an absolute bolometric magnitude of -0.77 and a bolometric correction of -1.02. If it has an apparent visual magnitude of 4.32, then what is its distance from Earth in parsecs?

    a. 65.2 pc
    b. 82.0 pc
    c. 131 pc
    d. 159 pc
    e. 167 pc

22. A planet orbits a star with a temperature of 6500K and a radius of 1.2 solar radii at a distance of 1.5 A.U. The planet has an albedo of 0.10. What is the planet's temperature, assuming it's a perfect blackbody?

    a. 250 K
    b. 273 K
    c. 308 K
    d. 329 K
    e. 346 K

23. Which constellation is not on the Zodiac?

    a. Cancer
    b. Taurus
    c. Cygnus
    d. Aries
    e. Gemini

24. One of the constellations that will be visible in Bhubaneshwar, India (20° 16′ 20.67″ N, 85° 50′ 1.85″ E) in December 2016 will be Piscis Australis. What is the brightest star in that constellation?
   a. Fomalhaut
   b. Rasalhague
   c. Alphekka
   d. Scheat
   e. Mirphak

25. Which of the following famous Messier objects is in the constellation Hercules?
   a. M13
   b. M31
   c. M42
   d. M57
   e. M83

26. What is M57?
   a. a globular star cluster
   b. a spiral galaxy
   c. a planetary nebula
   d. an open star cluster
   e. a stellar nursery

27. Which of the following famous Messier objects is in the constellation Orion?
   a. M1
   b. M8
   c. M13
   d. M27
   e. M42

28. What is the brightest star in the constellation Taurus?
   a. Aldebaran
   b. Algol
   c. Altair
   d. Hamal
   e. Mirach

29. What is the brightest star in the constellation Perseus?
   a. Algol
   b. Capella

c. Hamal

d. Mirphak

e. Scheat

30. Which of these Messier objects is NOT in the constellation Auriga?

    a. M35

    b. M36

    c. M37

    d. M38

31. To which constellation does your previous response belong?

    a. Taurus

    b. Gemini

    c. Cancer

    d. Orion

    e. Monoceros

32. What type of object is M44?

    a. Open cluster

    b. Globular cluster

    c. Planetary nebula

    d. Elliptical galaxy

    e. Stellar nursery

33. To which constellation does M44 belong?

    a. Gemini

    b. Cancer

    c. Leo

    d. Monoceros

    e. Lynx

34. Which three stars make up the Summer Triangle?

    a. Vega, Deneb, Altair

    b. Regulus, Sirius, Rigel

    c. Vega, Aldebaran, Antares

    d. Arcturus, Antares, Aldebaran

    e. Deneb, Rigel, Altair