

USAAAO First Round 2015

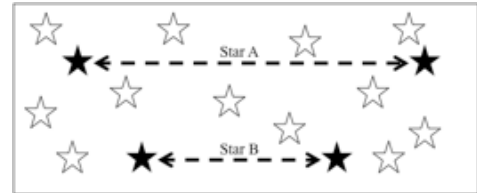
This round consists of 30 multiple-choice problems to be completed in 75 minutes. You may only use a scientific calculator and a table of constants during the test. The top 50% will qualify for the Second Round.

1. At arms length, the width of a fist typically subtends how many degrees of arc?
 - a. 1°
 - b. 5°
 - c. 10°
 - d. 15°
 - e. 20°
2. To have a lunar eclipse, the line of nodes must be pointing at the sun. The moon must also be in what phase?
 - a. New
 - b. First Quarter
 - c. Waxing Gibbous
 - d. Full
 - e. Waning Crescent
3. Mars orbits the sun once every 687 days. Suppose Mars is currently in the constellation Virgo. What constellation will it most likely be in a year from now?
 - a. Virgo
 - b. Scorpius
 - c. Aquarius
 - d. Taurus
 - e. Cancer
4. To calculate the field of view of a telescope, you measure the time it takes Capella (RA:5.27h, dec:45.98°) to pass across the eyepiece. If the measured time is 2 minutes and 30 seconds, what is the field of view in arcseconds?
 - a. 11.6'
 - b. 26.5'
 - c. 37.5'
 - d. 52.5'
 - e. 66.8
5. A telescope with focal length of 20 mm and aperture of 10 mm is connected to your smartphone, which has a CCD that measures 4.0mm by 4.0mm. The CCD is 1024 by 1024 pixels. Which is closest to the field of view of the telescope?
 - a. 1°

- b. 5°
 - c. 10°
 - d. 15°
 - e. 20°
6. What is its the resolution in arcseconds per pixel?
- a. $10''/\text{pixel}$
 - b. $40''/\text{pixel}$
 - c. $120''/\text{pixel}$
 - d. $1200''/\text{pixel}$
 - e. $3600''/\text{pixel}$
7. Comet 67P/Churyumov–Gerasimenko has an orbital period around the Sun of 6.44 years. What is its semimajor axis, in AU?
- a. 41.47
 - b. 16.34
 - c. 6.44
 - d. 3.46
 - e. 1.86
8. Which of the following techniques most directly constrains the mass of an exoplanet?
- a. Radial Velocity
 - b. Transit Timing
 - c. Microlensing
 - d. Direct Imaging
 - e. Proper Motion
9. Which two properties of galaxies does the Tully-Fisher relation utilize a correlation between?
- a. Luminosity and velocity dispersion
 - b. Luminosity and rotational velocity
 - c. Radius and metallicity
 - d. Luminosity and metallicity
 - e. Mass and surface brightness
10. A binary star system has two components: Star A and Star B. Star A has a mass of 5 solar masses, and Star B has the same mass as our Sun. Assuming circular orbits, how many times closer to the center of mass of the system is Star A than Star B?
- a. 1
 - b. 3
 - c. 5
 - d. 10
 - e. 25

11. What is, approximately, the peak wavelength of electromagnetic radiation emitted by a star at a temperature of 5,000 K?
- 580 Angstroms
 - 5,800 Angstroms
 - 4,600 Angstroms
 - 2,900 Angstroms
 - 58,000 Angstroms

12. Stars A and B are observed over a period of 1 year. Both stars appear to move with respect to the background stars from the position indicated on the left in the diagram below, to the position indicated on the right, and then back to the position on the left over the full year. Which star is further from the Earth?



- Star A
 - Star B
 - Both stars are the same distance from the Earth
 - Not enough information given
13. Suppose that you measure the parallax angle for a particular star to be 0.25 arcsecond. The distance to this star is
- 2 pc
 - 0.5 ly
 - 2 ly
 - 4 pc
 - 0.5 pc
14. On the main sequence, stars obtain their energy
- from chemical reactions.
 - from gravitational contraction.
 - by converting hydrogen to helium.
 - by converting helium to carbon, nitrogen, and oxygen.
 - from nuclear fission.
15. Star A has a radius that is 2 times larger than the radius of star B, and a surface temperature that is 2 times smaller than the surface temperature of star B. Therefore, star A is
- 4 times more luminous than star B.
 - 16 times less luminous than star B.
 - 16 times more luminous than star B.
 - as luminous as star B.
 - 4 times less luminous than star B.

16. A and B, two main sequence stars of the same spectral class, have apparent magnitudes of 17 and 12, respectively. If star A is 1 kpc away, what is the distance to star B?
- 10 pc.
 - 100 pc.
 - 10 kpc.
 - 50 pc.
 - 100 kpc.
17. Given that dark energy is vacuum energy, and that the densities of dark energy, dark matter and normal matter in the universe are currently $\rho_{\Lambda} = 6.7 \times 10^{-30} \text{ g/cm}^3$, $\rho_{DM} = 2.4 \times 10^{-30} \text{ g/cm}^3$ and $\rho_{\Lambda} = 0.5 \times 10^{-30} \text{ g/cm}^3$, what is the ratio of the density of dark energy at the time of the cosmic microwave background emission, to the current density of dark energy?
- 0.432
 - 2.31
 - 1
 - 2.5
 - 0.5
18. A type Ia supernova was observed in a galaxy with a redshift of 0.03. The supernova was determined to be 1.3×10^8 pc away from Earth. Determine the Hubble time using this observation.
- 1.41×10^{10} years
 - 1.41×10^{10} seconds
 - 1.33×10^9 years
 - 47.1 years
 - 1.33×10^9 seconds
19. In a main sequence star, gravitational collapse is counteracted by:
- Radiation pressure
 - Heat
 - Neutrinos
 - Electron degeneracy pressure
 - Neutron degeneracy pressure
20. If the hydrogen alpha line of a star, normally 656.3 nm, is observed to be 662.5 nm, what is the star's radial velocity relative to the Earth?
- 2.83×10^6 m/s
 - -2.83×10^6 m/s
 - 0.00945 m/s
 - 0.00945 m/s
 - -2.83×10^3 m/s

21. Within M-type stars, heat transfer occurs primarily through:
- radiation
 - conduction
 - convection
 - contraction
 - collapse
22. If a 1.2 solar mass star shows a radial velocity variation with a period of 9.2 days and amplitude of 32 m/s, estimate the minimum mass of the companion:
- 7.5×10^{26} kg
 - 1.2×10^{26} kg
 - 6.9×10^{27} kg
 - 5.1×10^{15} kg
 - 3.3×10^{27} kg
23. Calculate the planetary phase angle (counterclockwise from Earth, $a = 1.0$ AU) that a probe may correctly complete a Hohmann transfer orbit to Venus ($a = 0.7$ AU)
- 141 degrees
 - 17.5 degrees
 - 121 degrees
 - 241 degrees
 - 343 degrees
24. Calculate the blackbody equilibrium temperature of Mars. Take Mars's albedo to be 0.25 and semimajor axis to be 1.5 AU
- 300 K
 - 212 K
 - 161 K
 - 228 K
 - 260 K
25. Calculate the semimajor axis of a satellite orbiting the Earth with a velocity of 8.3 km/s at a distance of 300 km from the Earth's surface.
- 154 km
 - 308 km
 - 15800 km
 - 7900 km
 - 3950 km
26. On the night of December 23rd-24th 2015, an occultation of a bright star by the moon will be visible from Britain to Japan. Given that the moon is in full phase on December 25th, which star does the moon occult?
- Aldebaran (RA 4h 37m, Dec $16^\circ 31'$)

- b. Pollux (RA 7h 45m, Dec $28^{\circ} 2'$)
 - c. Regulus (RA 10h 8m, Dec $11^{\circ} 58'$)
 - d. Spica (RA 13h 25m, Dec $-11^{\circ} 14'$)
 - e. Antares (RA 16h 29, Dec $-26^{\circ} 26'$)
27. A synodic day on Mars is 24 hours and 40 minutes. If one Martian year is 687 earth-days, which of the following is closest to a sidereal day on Mars?
- a. 23h 56m
 - b. 24h 15m
 - c. 24h 37m
 - d. 24h 40m
 - e. 24h 42m
28. Suppose at the equator, a star passes through the zenith at local noon on the summer solstice. What is the right ascension and declination of the star?
- a. 0h 0°
 - b. 0h 90°
 - c. 6h 0°
 - d. 12h 0°
 - e. 12h 90°
29. 40 light years away, an exoplanet orbits a star of 5 solar masses every 14 years. Assuming this system has an inclination of 90° as viewed from Earth, what is the projected diameter of the exoplanet's orbit as viewed from Earth?
- a. 0.3''
 - b. 0.8''
 - c. 1.6''
 - d. 2.5''
 - e. 1.2''
30. A planet orbits a star with a projected semimajor axis of 0.24''. What is the necessary aperture size of a telescope than can resolve this orbit using 1000 nm light?
- a. 0.13 m
 - b. 0.52 m
 - c. 1.05 m
 - d. 3.10 m
 - e. 2.04 m