

Astronomy 103 – Midterm 3 – November 24, 2014

Instructions:

No books, notes or calculator are allowed. You have 50 minutes to complete the exam, and please do not turn to the next page until instructed to do so.

You may find the following information helpful:

- 1 AU = 3×10^8 km
- speed of light $c = 3 \times 10^5$ km/s
- Kepler's 3rd law:

$$a^3 = P^2$$

with the period P in years and semi-major axis a in AU.

- Newton's law of gravity:

$$F = \frac{GMm}{r^2}$$

- Peak wavelength and temperature of blackbody radiation:

$$\lambda = \frac{3 \times 10^6}{T} \text{ nm}$$

with wavelength λ in nm ($1 \text{ nm} = 10^{-9} \text{ m}$) and temperature T in Kelvin.

- Relationship between frequency f and wavelength λ of light:

$$\lambda = \frac{c}{f}$$

- Conversion of mass into energy: $E = mc^2$
- Relationship between brightness B and distance d :

$$B_2 = B_1 \times \frac{d_1^2}{d_2^2}$$

- Relationship between luminosity L , temperature T and radius R of stars:

$$L = 4\pi\sigma T^4 R^2$$

where $4\pi\sigma$ are constants.



Figure 1: Messier 81 (HST)



Figure 2: Messier 101 (HST)



Figure 3: Abell 1689 (Hubble)

1. The density of a neutron star is closest to:
 - a) 10 kg / teaspoon
 - b) 1 atom / cubic centimeter
 - c) 5 tons / teaspoon
 - d) 1 billion tons / teaspoon

2. A pulsar is a
 - a) oscillating white dwarf
 - b) oscillating neutron star
 - c) rotating white dwarf
 - d) rotating neutron star
 - e) none of the above

3. A black hole is likely to be the end of stellar evolution for what type of main sequence star?
 - a) O
 - b) M
 - c) G
 - d) A

4. What can escape from within a black hole?
 - a) Neither light nor matter
 - b) Light only
 - c) Both light and matter
 - d) Matter only

5. The mass of a black hole candidate can be found by
 - a) measuring its luminosity and distance
 - b) measuring the speed of an orbiting companion and the radius of its orbit
 - c) measuring the radius of its event horizon only
 - d) measuring its luminosity and the radius of its event horizon

6. Which of the following is not a terrestrial planet?
 - a) Mars
 - b) Earth
 - c) Neptune
 - d) Mercury
 - e) Venus

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7. Which of the following is not a Jovian planet?
- a) Venus
 - b) Jupiter
 - c) Neptune
 - d) Saturn
 - e) Uranus
8. Compared to terrestrial planets, Jovian planets are
- a) larger and denser
 - b) smaller and denser
 - c) larger and less dense
 - d) smaller and less dense
9. Most of the solar system's mass is in
- a) the Sun
 - b) comets
 - c) asteroids
 - d) meteoroids
 - e) planets
10. When a rotating cloud contracts, it
- a) spins slower and flattens
 - b) spins faster and flattens
 - c) spins slower and heats up
 - d) spins faster and heats up
11. Why do all of the planets have orbits that lie in nearly the same plane and that are in the same direction – counterclockwise looking down on the solar system from far above the Earth's North Pole?
- a) When they were captured by the Sun, the Sun was moving past a cluster of planets, and all of those planets were on one side of its path.
 - b) Shortly after they formed, the planets were moving in random directions. In the 4 1/2 billion years since then, the Sun's gravity has pulled them into the same plane.
 - c) The planets and Sun all formed from a cloud of gas and dust that contracted as it cooled. As the cloud contracted, its spin increased and it flattened. By the time the planets formed, the cloud was a flat spinning disk.

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12. Their orbits usually lie between Mars and Jupiter.
- a) comets
 - b) meteoroids
 - c) asteroids
13. They often pass the Sun once and then leave the solar system.
- a) comets
 - b) meteoroids
 - c) asteroids
14. They have the lowest average density of the three kinds of objects.
- a) comets
 - b) meteoroids
 - c) asteroids
15. They are typically small pebbles.
- a) comets
 - b) meteoroids
 - c) asteroids
16. What is the reason for the difference between typical meteors and typical meteorites?
- a) The only meteors that do not burn up in the atmosphere are the large ones. These are all asteroid fragments.
 - b) The only meteors that do not burn up in the atmosphere are the rocky ones. These all come from comets.
 - c) Meteorites are the meteors that burn up in the atmosphere.
 - d) Meteors are ice balls, while meteorites are great balls of fire.
17. Comet tails extend from the comet in what direction?
- a) away from the Sun
 - b) away from the Sun when the comet is approaching the Sun and toward the Sun when the comet is moving away
 - c) toward the Sun

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18. The greenhouse effect makes this the planet with the hottest average temperature in the solar system.
- a) Jupiter
 - b) Mercury
 - c) Mars
 - d) Venus
 - e) Uranus
19. This planet is about 20 AU from the Sun.
- a) Jupiter
 - b) Mercury
 - c) Mars
 - d) Venus
 - e) Uranus
20. This planet is the only one of those listed that was not known to the ancient Greeks.
- a) Jupiter
 - b) Mercury
 - c) Mars
 - d) Venus
 - e) Uranus
21. This planet has no liquid water on its surface, but does have channels which are probably the streambeds of ancient rivers.
- a) Jupiter
 - b) Mercury
 - c) Mars
 - d) Venus
 - e) Uranus
22. The average density of the Earth is about
- a) the density of water
 - b) the density of iron
 - c) the density of black volcanic rock
 - d) the density of ice

23. The Earth's atmosphere is primarily
- a) carbon dioxide and oxygen
 - b) water vapor and carbon dioxide
 - c) nitrogen and oxygen
 - d) methane and ammonia
 - e) nitrogen and water vapor
24. Mars is larger than the Earth.
- a) TRUE
 - b) FALSE
25. What are the main constituents of Mars?
- a) hydrogen and rock
 - b) rock and ice
 - c) water, methane and ammonia
 - d) hydrogen and helium
 - e) rock and iron
26. The crater-covered surface of this terrestrial planet resembles the surface of the Moon.
- a) Mars
 - b) Mercury
 - c) Earth
 - d) Venus
 - e) Jupiter
27. Olympus Mons is a volcano on this planet.
- a) Mars
 - b) Mercury
 - c) Earth
 - d) Venus
 - e) Jupiter
28. Jupiter emits more energy than it receives from the Sun.
- a) TRUE
 - b) FALSE

29. Dry ice (frozen carbon dioxide) vastly enlarges this planet's polar caps in the winter for each cap.
- a) Mars
 - b) Mercury
 - c) Earth
 - d) Venus
 - e) Jupiter
30. Voyager discovered active volcanoes on what moon?
- a) Phobos
 - b) Ganymede
 - c) Titan
 - d) Europa
 - e) Io
31. The Great Red Spot is
- a) a desert on Mars
 - b) a crater on the moon
 - c) a persistent storm on Jupiter
32. Pluto is now classified as
- a) a cold terrestrial planet
 - b) a large Kuiper belt object
 - c) a comet in a bound orbit
33. Pluto is the largest of the known plutoids.
- a) TRUE
 - b) FALSE
34. Plutoids are
- a) comets in the Oort cloud
 - b) balls of ice and rock in the Kuiper belt
 - c) carbonaceous chondrites between Mars and Jupiter
 - d) the moons of the Jovian planets that are primarily ices of water, ammonia, carbon dioxide, and methane

35. Compared to Population I stars, Population II stars are
- older, with a smaller fraction of heavy elements
 - younger, with a larger fraction of heavy elements
 - older, with a larger fraction of heavy elements
 - younger, with a smaller fraction of heavy elements
36. What population of stars are found in globular clusters?
- Population I only
 - Population II only
 - both Population I and Population II
 - neither
37. Each method of finding distances (or distance indicator) listed below is used to find the distance to a set of objects. Match the indicators to the objects.
- 1 radar bouncing
 - 2 parallax
 - 3 main-sequence matching ("spectroscopic parallax")
 - 4 Cepheid variables
- A distances to planets
B distances to the nearest stars
C distances to nearby galaxies
D distances to stars in the Milky Way more than 2,000 ly away
- A and 2, B and 3, C and 1, D and 4
 - A and 3, B and 1, C and 4, D and 2
 - A and 1, B and 2, C and 4, D and 3
 - A and 4, B and 3, C and 1, D and 2
38. The Milky Way is
- a spiral galaxy
 - an elliptical galaxy
 - a globular cluster
 - an irregular galaxy

39. In which part of the Milky Way galaxy is the Sun?
- a) halo
 - b) disk
 - c) central bulge
 - d) none of these
40. Most of the mass of the Milky Way galaxy is
- a) in the spiral arms
 - b) in the disk, but not in the spiral arms
 - c) in the nuclear bulge
 - d) invisible and in the halo
 - e) in the brightest, most massive stars of halo
41. The strongest evidence for a black hole in the center of the Milky Way is
- a) Observed orbits of stars show nearly 4 million times the mass of the Sun is in a region less than 6 light-hours across.
 - b) Doppler shifts of 21-cm radiation from the galactic center imply that roughly 50 million times the mass of the Sun lies within a region 3 light-years across,
 - c) Observed orbits of stars show nearly 30 million times the mass of the Sun is in a region less than 8 light-seconds across.
 - d) Doppler shifts of 21-cm radiation from the galactic center imply that over one billion times the mass of the Sun lies within a region 3 light-years across.
 - e) None of these is thought to be evidence for a central black hole.
42. What is the approximate diameter of the disk of the Milky Way?
- a) 100,000 ly
 - b) 300,000 ly
 - c) 3 million ly
 - d) 100 million ly
43. Why is 21 cm radio emission useful for studying the structure of the Milky Way
- a) The waves penetrate dusty cocoons to reveal star formation
 - b) The waves are not absorbed by Galactic black holes
 - c) It can be used to map the hydrogen gas in the spiral arms
 - d) Radio waves provide a distance measurement like parallax

44. What convincing evidence do we have for the presence of a relatively dense halo of invisible "dark matter" permeating the Milky Way?
- a) Light from distant stars is blocked by some unseen effect
 - b) Much of the matter making up the Milky Way is far colder than it should be
 - c) Many of the stars in the Milky Way are losing energy, as though passing through a dense cloud of material
 - d) Stars further out in the galactic disk seem to be moving at about the same speed as those that are further in, when they should be moving slower.
45. What is the rough proportion (by total mass) in the universe of well-understood visible matter to poorly understood "dark" matter?
- a) The amount of dark matter is about one percent the amount of visible matter
 - b) The amount of dark matter is about one fifth the amount of visible matter
 - c) The amount of dark matter is about equal to the amount of visible matter
 - d) The amount of dark matter is about five times the amount of visible matter
 - e) The amount of dark matter is about one hundred times the amount of visible matter
46. How are galaxies spread out throughout the universe
- a) They are grouped into clusters that are spread more-or-less evenly throughout space
 - b) They are grouped into clusters that in turn are clumped into superclusters
 - c) Galaxies are densest near us, and become more spread out as we look further out
 - d) Galaxies are densest near a distant point in space, which can be interpreted as the center of the universe, and are ore spread out as one looks way from that point.
47. What is Hubble's Law based on
- a) More distant galaxies showing greater blueshifts
 - b) Distant galaxies appearing proportionally dimmer
 - c) More distant galaxies showing greater redshifts
 - d) Slowly varying Cepheid variables appearing brighter
48. What is the Hubble classification for the galaxy shown in Figure 1 (see page between Instructions and Questions)?
- a) E
 - b) Sa
 - c) Sc
 - d) Irregular
 - e) Quasar

49. What is the Hubble classification for the galaxy shown in Figure 2?
- a) E
 - b) Sa
 - c) Sc
 - d) Irregular
 - e) Quasar
50. Most of the galaxies shown in Figure 3 have what Hubble classification?
- a) E
 - b) Sa
 - c) Sc
 - d) Irregular
 - e) Quasar

Happy Thanksgiving!