

Name:

**Directions:** Listed below are twenty (20) multiple-choice questions based on the material covered by the lectures thus far. Choose the correct response from those listed, **along with at least a one (1) sentence justification for your answer**. Alternate justification techniques include math calculations and labeled sketches. Each question is worth 5 points: 2 for the letter response and 3 for the justification. Collaboration with your peers is permitted, but all justifications must be in your own words. If you are unsure about a question, make an educated guess, and justify your guess (which can include why you can rule out certain choices from the list). If you get stuck, **please seek assistance from your peers, the TA, or the professor**. Note: It may be helpful to place your answers on a separate sheet of paper and staple it to this assignment sheet.

**WARNING:** Please **DO NOT** copy material word for word from sources such as textbooks, a peer's notes, online references (i.e. Google or Wikipedia), etc in any responses to homework, quiz, or exam questions. Ideas should be expressed in your own words. Not only does this protect you from illegal acts of plagiarism and/or accusations of cheating, but it also aids your future studying by having ideas expressed in a way that you, personally, can best understand. If for some reason you **MUST** quote text from a source in your answer, properly reference your quote.

1. The energy generation process inside a white dwarf star is
  - A) the combining of protons and electrons to form neutrons within its core.
  - B) the helium flash—very efficient and rapid helium fusion.
  - C) nonexistent; a white dwarf star is simply cooling by radiating its original heat.
  - D) hydrogen fusion.
2. Which of the following types of stars or stellar remnants cannot have a mass larger than about 1.4 times the mass of the Sun?
  - A) neutron star
  - B) red giant
  - C) black hole
  - D) white dwarf
3. Type II supernovae show prominent lines of hydrogen in their spectra, whereas hydrogen lines are absent in spectra of Type Ia supernovae. Why is this? (HINT: Think about the type of star that gives rise to each of the two types of supernova.)
  - A) Massive stars have burned all of their hydrogen into heavier elements, whereas low-mass stars still have large hydrogen-rich envelopes.
  - B) Massive stars contain large amounts of hydrogen, whereas white dwarfs are mostly carbon and oxygen.
  - C) White dwarfs have a thick surface layer of hydrogen, whereas neutron stars contain no hydrogen at all.
  - D) Massive stars contain large amounts of hydrogen, whereas neutron stars contain no hydrogen at all.

4. Measurements suggest that light first arrived at Earth from the Cassiopeia A supernova about 300 years ago and that this supernova is about 10,000 light years away from Earth. When did the explosion actually occur?
- It is not possible to say when it occurred from the information given.
  - 300 years ago, or about 1700 AD
  - 9700 years ago, or about 7700 BC
  - 10,300 years ago, or about 8300 BC
5. From observations of supernova explosions in distant galaxies, it is predicted that there should be about five supernovae per century in our galaxy, whereas we have seen only about one every 300 years from Earth. Why is this?
- Most supernovae occur in the Milky Way, which can be seen only from the southern hemisphere where, until recently, there were no observers of the sky.
  - Our galaxy is peculiar in that the majority of stars are old, well beyond the supernova stages of evolution.
  - The majority of supernovae produce no visible light, only radio and X-ray radiation, which we have only been able to observe for the past three decades.
  - Most supernovae occur in the galactic plane where interstellar dust obscures our view of them from Earth.
6. What is the escape velocity of matter from the surface of a 1-solar-mass neutron star with a diameter of 28 km? (See Box 7-2, Freedman and Kaufmann, *Universe*, 7th ed.)
- about 0.46 of the speed of light
  - quite small, much less than 1/10 of the speed of light
  - 10 times greater than the speed of light
  - about  $\frac{3}{4}$  the speed of light
7. Suppose you are in the Space Shuttle in orbit around the Earth at a speed of 7 km/s, and at some particular time your direction of travel is straight toward the Sun. The speed of light in a vacuum is 300,000 km/s. What speed will you measure for the light from the Sun?
- 300,000 km/s
  - 300,014 km/s because your speed is added to that of the light and relativistic contraction has shortened your reference meter sticks
  - 299,993 km/s because relativistic contraction has shortened all distances, including your reference meter sticks
  - 300,007 km/s because your speed is added to that of the light
8. You are standing on the gangplank of your spaceship on Mars when you see an identical spaceship go past Mars at 90% of the speed of light. When you look closely at this spaceship, how do you find that it compares to your own spaceship?
- The moving spaceship looks shorter, and time on it appears to run more slowly than on yours.
  - The moving spaceship looks longer, and time on it appears to run faster than on yours.
  - The moving spaceship looks shorter, and time on it appears to run faster than on yours.
  - The moving spaceship looks longer, and time on it appears to run more slowly than on yours.

9. Einstein's principle of equivalence in his general theory of relativity asserts that
- A) the behavior of all types of atoms in a gravitational field is equivalent.
  - B) all objects are attracted toward all other objects in the universe by gravitational forces.
  - C) being at rest in a gravitational field is equivalent to being in an upwardly accelerated frame of reference in a gravity-free environment.
  - D) if person B is in a rapidly moving reference frame (moving at constant velocity), then person B will observe exactly the same effects for person A as person A observes for person B.
10. According to Einstein's general theory of relativity, a clock that ticks at a regular rate far from a source of gravity will appear to tick
- A) at the same rate in a gravitational field if it is an atomic clock but at a slower rate if it is a mechanical clock.
  - B) at the same rate wherever it is placed in a gravitational field.
  - C) faster, the closer it comes to the source of gravity.
  - D) slower, the closer it comes to the source of gravity.
11. What happens to the wavelength of light as it travels outward through the gravitational field of a planet, a star, or other massive object?
- A) It stays the same but the intensity of the light decreases.
  - B) It stays the same but the energy of each photon decreases.
  - C) It decreases.
  - D) It increases.
12. If the Sun were replaced by a 1-solar-mass black hole, then the Earth would
- A) continue to orbit the black hole in precisely its present orbit.
  - B) move into an elliptical orbit passing close to the black hole, with its farthest distance from the black hole equal to 1 AU.
  - C) spiral quickly into the black hole.
  - D) head off into interstellar space along a straight line at a tangent to its original orbit around the Sun.
13. The gravitational redshift of light leaving the surface of Sirius B is  $\Delta\lambda/\lambda = 3.0 \times 10^{-4}$ . What velocity of Sirius B (relative to the Earth) would be needed to produce an equivalent Doppler shift?
- A) 90 km/sec away from Earth
  - B) 90 km/sec toward Earth
  - C) 300 km/sec away from Earth
  - D) 300 km/sec toward Earth
14. In a binary star system, an unseen component is found to have a mass of about 8 solar masses. If this were a normal star, then it would be visible, so it must be a collapsed object. Theoretical considerations tell us that it must be
- A) a white dwarf.
  - B) a black hole.
  - C) a neutron star.
  - D) a brown dwarf.

15. X rays that come from the vicinity of a black hole actually originate from
- A) well inside the event horizon.
  - B) its exact center, or singularity.
  - C) relatively far away from the black hole, where matter is still relatively cool.
  - D) just outside the event horizon, on the accretion disk.
16. Which component of our galaxy accounts for interstellar extinction—the dimming of light from distant objects?
- A) molecules such as H<sub>2</sub> and CO, which are strong absorbers, in molecular clouds.
  - B) dust
  - C) the so-called dark matter, because its absorbing properties render it invisible in the galaxy.
  - D) cool hydrogen gas
17. What would be the wavelength of maximum emission of interstellar dust grains at a temperature of 65 K? (See Wien's law, Section 5-4, Freedman and Kaufmann, *Universe*, 7th ed.)
- A) 450 μm
  - B) 22.5 μm
  - C) 45 μm
  - D) 2.25 μm
18. Where would you look in our galaxy to find older, metal-poor stars?
- A) in the disk and spiral arms
  - B) everywhere in the galaxy
  - C) in the globular clusters in the galactic halo
  - D) only at the galactic center
19. In our galaxy, young metal-rich stars are found
- A) in the disk and spiral arms.
  - B) everywhere in the galaxy.
  - C) only at the galactic center.
  - D) in the globular clusters, in the galactic halo.
20. The distance to the globular cluster M55 has been determined to be 6500 pc by analysis of the variable RR Lyrae stars in the cluster. How does the apparent brightness of these stars compare with the apparent brightness of the Sun? (Hint: RR Lyrae stars are believed to have a luminosity of about 100 times that of the Sun.)
- A)  $5.6 \times 10^{-17}$
  - B)  $2.5 \times 10^{-7}$
  - C)  $2.4 \times 10^{-6}$
  - D) Unable to determine