Astronomy 110
Homework #12
Assigned: 04/24/2007
Due: 05/01/2007

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. Why does the central bulge of a spiral galaxy appear red when compared to the color of the spiral arms?
   A) UV light from the very hot stars in the bulge has excited hydrogen gas, which is emitting the red Balmer H_α light as a consequence.
   B) There is no star formation there, and the star population is dominated by old, long-lived, low-mass red stars.
   C) The light from the stars in this region is not Doppler-shifted by galactic rotation, in contrast to that from spiral-arm stars.
   D) Dust surrounding the bulge has preferentially scattered the blue light from the bulge stars.

2. Which of the properties below plays the largest role in determining a galaxy's classification?
   A) The number of stars in the galaxy
   B) The amount of dark matter in the area around the galaxy
   C) The redshift of the galaxy's spectrum
   D) The ratio of the galaxy's bulge-to-disk size

3. Which of the following galaxy types contain little or no interstellar dust or gas?
   A) ellipticals
   B) barred spirals
   C) spirals
   D) irregular galaxies

4. What two properties are involved in the Tully-Fisher relation that allow for distances to be calculated to distant galaxies?
   A) The redshift of a galaxy vs. its recession velocity
   B) The color of a galaxy vs. its star-formation rate
   C) The luminosity of a galaxy vs. the rotation velocity of its stars and gas
   D) The distance of a galaxy vs. its measured parallax

5. Because of the expansion of space, we see all distant galaxies moving away from us, with more distant galaxies moving faster. An observer in one of these distant galaxies would see
   A) all galaxies moving away from the observer, with more distant galaxies moving faster.
   B) all galaxies on one side of the observer moving toward the observer, and all galaxies on the other side moving away from the observer, with more distant galaxies moving faster.
   C) all galaxies moving away from the observer, with closer galaxies moving faster.
   D) all galaxies moving toward the observer, with more distant galaxies moving faster.

6. The Hercules cluster of galaxies shown in Fig. 26-19 (Freedman and Kaufmann, *Universe,* 7th ed.) is at a distance of 650 million light years from our galaxy. Using a Hubble constant of 23 km/s/Mly, at what wavelength will the Balmer H_α spectral line, with rest wavelength = 656.3 nm, be seen in the spectrum of a galaxy in this cluster?
   A) 623.6 nm
   B) 689.0 nm
   C) 656.7 nm
   D) 32.7 nm

7. What evidence is there for considerable extra mass within galaxies which does not produce visible light—the so-called dark matter?
   A) The rotation curve of galaxies, showing orbital speeds of material, remains flat to large distances from the galactic centers, and does not follow a Kepler-type curve.
   B) the appearance of many very dark spots within the galaxy, evidence of numerous low-mass black holes scattered throughout the galaxy
   C) widespread evidence for gravitational lensing of background stars in a galaxy by massive but invisible objects in the foreground
   D) intense output of X rays from very hot gas between the stars, originating in otherwise dark regions

8. In the expansion of the universe, the expansion takes place
   A) only between objects separated by a vacuum; as a result, our bodies do not expand but the Earth-Moon system does.
   B) primarily in the huge voids between clusters of galaxies: "small" objects like galaxies or the Earth do not expand.
   C) only over distances about the size of a galaxy or larger; consequently, our galaxy expands but the solar system does not.
   D) between all objects, even between the atoms in our bodies, although the expansion of a person is too small to be measured reliably.

9. What is the general meaning of the cosmological principle?
   A) There is no unique time in our universe; it has always looked the way it is now and will always do so.
   B) We do not occupy a special location in space, because the universe is the same everywhere, on average.
   C) The universe appears to be expanding outward, but this is because of our motion as we descend into a super-duper massive black hole which has distorted space to produce the illusion of general "expansion."
   D) We occupy a very special location near the original location of the Big Bang, because everything appears to be moving away from this location as the universe expands.

10. The resolution of Olber's paradox (i.e., the reason why the sky is dark at night) is that
   A) we cannot see those stars that are farther away from us than the distance that light has traveled since the beginning of the universe.
   B) matter cannot have traveled farther than light has traveled during the age of the universe, so there ARE NO stars beyond a certain distance from us.
   C) the light from very distant stars is bent out of our line of sight by the gravitational fields of nearby galaxies.
   D) the light from stars beyond a certain, very large distance is completely absorbed by matter between us and the star.

11. Calculate the age of the universe if Hubble's constant, H_0, is 71 km/s/Mpc.
   A) 2.27 million years
   B) 1.43 billion years
   C) 13.8 billion years
   D) 1,380 billion years

12. Why does the observable universe have an "edge"?
   A) because there are so many galaxies in the universe that every line of sight eventually hits a galaxy, stopping us from seeing any farther
   B) because the density of neutrinos at the "edge" is so large that photons cannot pass through, preventing us from seeing beyond this point
   C) because absorbing matter prevents us from seeing out past a certain distance
   D) because we cannot see any farther than the distance that light has traveled over the lifetime of the universe

13. I thought that the Big Bang was hot! If the cosmic microwave background radiation is the radiation left over from the Big Bang, why then is it only 3 K?
   A) The Big Bang itself was hot, but the temperature decreased as the universe expanded, and the temperature now is 3 K.
   B) It is not from the Big Bang itself—it is from cold, intergalactic hydrogen clouds that are left over from the Big Bang.
   C) The Big Bang itself was hot, but by the time the universe became transparent the temperature had already decreased to 3 K.
   D) The Big Bang was not hot—its temperature was the same as we observe it now from the cosmic background radiation.

14. Why does the cosmic microwave background appear to be slightly warmer in one direction in the sky and slightly cooler in the opposite direction?
   A) because this is the direction in which the Big Bang occurred, hence we are seeing the remnant of the explosion in this direction.
   B) because the center of the Local Group of galaxies is in this direction and this is a bright source of microwaves.
   C) because the radiation in one direction is Doppler-shifted to shorter wavelengths by the Earth's motion in space and to longer wavelengths in the other direction.
   D) because the amount of dark matter in that direction in space has focused the radiation slightly by gravitational lensing, making this direction appear hotter.

15. As we look at more distant regions of space, we see those regions as they existed at earlier times, but our farthest views are blocked by a "wall"—beyond which the universe is opaque. What event occurred at the time marked by this wall?
   A) Electrons and protons combined to form neutral hydrogen atoms, making the universe transparent for the first time.
   B) Quarks combined to form neutrons and protons, removing γ-ray absorbers for the first time.
   C) Gravity froze out as a separate force.
   D) Electrons and protons combined to form helium atoms, removing major absorbers of electromagnetic radiation from the universe for the first time.

16. Measurement of structure in the cosmic microwave background radiation has recently indicated that we live in a flat universe between a closed and an open universe and yet the measured density of detected matter and radiation is only 20–40% of the critical density required for a flat universe. In what form is the other 60−80% of the "matter" likely to be?
    A) antimatter, which generates a negative gravitational effect and emits radiation only if it meets matter and is annihilated
    B) neutrinos, which have very little rest mass and are very difficult to detect, but are very abundant
    C) miriads of small primordial black holes, whose gravitational effects are spread throughout the universe and which emit no radiation
    D) dark energy, emitting no radiation and generating no detectable gravitational effects

17. The inflationary epoch accomplished all of the following *except one*. Which is the exception?
    A) took whatever curvature the early universe had and flattened it
    B) allowed the early, pre-inflationary universe to be very small and thus capable of thermal equalization
    C) permitted matter to move faster than the speed of light for a brief period
    D) forced the observed density of the universe to be equal to the critical density to great precision.

18. The forces of gravity and electromagnetism are long-range forces, extending in principle from their source (mass and electric charge respectively) to infinity. Why is it that in our universe, only gravity extends to infinity, whereas electromagnetic forces are much more limited in extent?
    A) Electromagnetic forces from charged particles will move other charged particles around to produce a uniform charge distribution and therefore zero electromagnetic forces, whereas gravity concentrates mass and enhances the overall gravity force.
    B) All atoms are electrically neutral so, in reality, the electromagnetic force never reaches beyond the size of an atomic nucleus.
    C) Gravity and electromagnetism are one and the same force, with electromagnetic effects extending over limited spatial ranges and transforming into gravitational forces at large distances from matter.
    D) Electromagnetic forces from positive charges are canceled by negative charges, whereas there are no negative "masses" to cancel the gravitational force.

19. Over what time during the Big Bang were all four fundamental forces unified?
    A) until 10^{-24} second after the start of the Big Bang, when the inflationary epoch ended
    B) during the first 300,000 years from the start of the Big Bang, when the universe was dominated by radiation
    C) during the Planck time, up to 10^{-43} second after the start of the Big Bang
    D) until 10^{-6} second after the start of the Big Bang, when the era of quark confinement ended

20. Where and how was most of the helium in the universe created?
    A) by nuclear reactions in the cores of stars, and was then thrown out into space by supernovae
    B) by the collision of cosmic rays with hydrogen nuclei in interstellar gas clouds
    C) by high-energy processes during the collapse of pregalactic clouds during the formation of galaxies
    D) by nuclear reactions during the Big Bang