Astronomy II (Astr 1020)
Fall 2009
Prof Richard Ignace

HOMEWORK #3

Notes:

You will need a calculator, a pencil, and a standard scantron.

Each question has one correct answer. Choose the best answer for each. Mark your answer on the scantron.

This homework is due at the beginning of class on December 1. Late homeworks will not be accepted.

1. A galaxy that is four times as far away as another appears will based on the Hubble law move _____ times as fast as the closer one

   a) 1/16
   b) 1/4
   c) just as fast
   d) 4
   e) 16

2. Elliptical galaxies have few if any new stars. Why is this?

   a) The central black holes of ellipticals have consumed all the gas that would have made new stars.
   b) Ellipticals never have central black holes, and it is these that would normally stimulate star formation.
   c) Ellipticals form without any gas.
   d) All the gas has been used up in previous generations of star formation.
   e) The gravity of ellipticals is too small to keep any gas.

3. Why is it that galaxy mergers produce a lot of star formation (referred to as a "starburst")?

   a) The collision leads to the compression of gas clouds, and so higher densities and rapid cloud collapse.
   b) The collision of the central black holes of the two galaxies forces them to "burp" all the stars they have ever previously engulfed.
   c) The collision leads to stars hitting each other, resulting in splits and the production of extra stars.
   d) The collision leads to stars passing close to each other, and this gravitationally "rips" off the outer atmospheric layers of the stars to form new clouds of gas and new star formation.

4. Which of the following statements about globular clusters is NOT true:

   a) A globular cluster is a large collection of 100,000 to 10 million stars orbiting each other.
   b) There are about a hundred globular clusters in orbit around our galaxy.
   c) Many globular clusters have ages greater than 10 billion years
   d) Globular clusters tend to have a very low heavy element content
   e) You can usually find globular clusters in the spiral arms

5. Which of the following is a difference between a typical halo star and the Sun.

   a) A halo star will tend to be older.
   b) A halo star will tend to have fewer heavy elements.
   c) A halo star tends not to be found in the Milky Way disk.
   d) All of the above are valid differences.
   e) None of the above are valid differences.

6. Based upon what we know about the structure of the Milky Way galaxy and our location in it, which one of the following is true of the sky as we observe it?

   a) Stars in the Milky Way appear to be evenly distributed over the whole sky.
   b) Almost all of the stars we see are in the Milky Way halo since the disk is filled with so much intervening dust and gas.
   c) There appear to be more galaxies at low galactic latitudes because the halo material of the Milky Way blocks our view at high galactic latitudes.
   d) There appear to be more galaxies at high galactic latitudes because there is less dust and gas blocking the line of sight out of the Milky Way in that direction.

7. In the Milky Way galaxy, the Sun is located

   a) in a spiral arm, about 2/3 of the way out from the center.
   b) very near the nuclear bulge of the galaxy.
   c) in a spiral arm on the outer edge of the galaxy.
   d) in the galactic halo.
   e) in the outer parts of the large globular cluster known as M13.

8. Select the correct statement.

   a) Globular clusters tend to be located in the Milky Way disk.
   b) Population II stars are metal-poor.
   c) Population I stars are metal-poor.
   d) Open clusters tend to be located in the Milky Way halo.

9. Why does a galaxy collide with other galaxies more often than its stars collide with each other?

   a) Galaxies have dark matter
   b) The universe is expanding
   c) Galaxies have much larger mass than stars, and hence stronger gravitational forces
   d) Galaxies are relatively large compared to their typical separations

10. Galactic cannibalism refers to

    a) the merging of galaxies
    b) the destruction of a galaxy's globular clusters by the galaxy's nucleus
    c) galaxies drawing their gas from the intergalactic medium
    d) binary galaxies
    e) the destruction of a galaxy's stars by its central black hole

11. The most reliable distances to nearby galaxies are determined

    a) by using large telescope to image highway signs
    b) by measuring the period and brightness of Cepheid variable stars
    c) by measuring the trigonometric parallax
    d) by measuring the redshift and applying Hubble's Law
    e) by emitting a radar pulse, measuring the time it takes to receive an echo, and knowing that the speed of the radar signal is c

12. The rotation curve of the Milky Way is "flat" at about 220 km/s for most stars, just like the Sun's circular orbital speed. Consider a star that is only one third of the distance from the Galactic Center as the Sun. How long will it take this star to orbit once around the Milky Way as compared to the Sun's orbital period? (Drawing a sketch helps.)

    a) 1/9 the time
    b) 1/3 the time
    c) the same amount of time
    d) 3 times longer
    e) 9 times longer

13. Olbers' paradox is best summarized by which of the following?

    a) If the Universe has an infinite age, why hasn't it collapsed?
    b) If the Universe is finite in space, does it have an edge?
    c) If the Universe is finite in time, what occured before the Big Bang?
    d) If the Universe began as a single "point," how can it be infinite?
    e) Why is the night sky dark?

14. The Cosmological Principle implies which one of the following is valid:

    a) The Doppler effect and Euclidean geometry
    b) Newtonian mechanics and relativity
    c) Homogeneity and isotropy of the Universe
    d) Hubble's Law and the curvature of the Universe
    e) Great taste and less filling

15. Why does the presence of quasars at great distances (and only at great distances) from our galaxy imply that the Perfect Cosmological Principle is not valid?

    a) The distances and radial velocities for the quasars violate the Hubble relation.
    b) They show that the Universe was generally different at an earlier time.
    c) The quasars are so bright that no known energy source can possibly power them.
    d) The great distances to the quasars allow us to observe gravitational lensing effects.
    e) There is no evidence that galaxies have formed at such great distances.

16. The Principle of Equivalence states that

    a) Before inflation, there was an epoch in which all four forces were combined into one.
    b) The Microwave Background Radiation has a temperature equivalent to that of a perfect radiator ("black body") of 3 K temperature.
    c) Gravitational attraction and accelerated motion are equivalent.
    d) Light can be described both as a particle and as a wave.
    e) After inflation, our Universe evolved into a flat geometry.

17. One of the curious results of General Relativity and curved spacetime is gravitational redshift. When light is emitted by a star, its wavelength changes (gets longer) as it travels outward through space. The formula for this shift is $\Delta\lambda/\lambda_0 = GM/Rc^2$, where M is the mass of the star, R its radius, G the gravitational constant, and c is the speed of light. The new wavelength is $\lambda = \lambda_0 + \Delta\lambda$, for λ_0 the original wavelength. (Like getting a raise in salary, where you have your old salary, your raise, and then your new salary is the sum.) Consider a neutron star of $2M_\odot$ and 10 km. If light of 3000 Å is emitted at the surface of the star, what wavelength will it have upon reaching the Earth?

    a) 900 Å
    b) 2110 Å
    c) 3000 Å
    d) 3900 Å

18. The fact that the Microwave Background Radiation has almost exactly the same spectrum in all directions in the sky is evidence that the Universe is:

    a) Isotropic
    b) Expanding
    c) Redshifted
    d) Filled with dust clouds
    e) Filled with stars

19. What observational fact is explained by inflation?

    a) The existence of black holes.
    b) The isotropy of our Universe.
    c) The primordial abundances of H and He.
    d) The formation of elliptical galaxies.

20. In Special Relativity observers moving at different speeds fail to agree on simultaneity. One of the consequences is a thing called time dilation: Moving clocks tick slower. Suppose you have a friend who is an astronaut. In a test flight, the astronaut reaches escape speed from the Earth at 11 km/s. Your friend's watch ticks slower than yours by the factor $\Gamma = \sqrt{1 - v^2/c^2}$, where c is the speed of light, and v is the rocket speed. Determine the **difference** in these clock rates, $1 - \Gamma$. (This means when 1 second passes on your watch, some fraction of a second Γ will pass on your friend's watch. Find the difference between the two values.)

    a) 6.72×10^{-10} seconds
    b) 1.34×10^{-9} seconds
    c) 0.99999 seconds
    d) 0.5 seconds

21. The flatness and horizon problems

    a) show that the Big Bang theory is wrong.
    b) are solved if there was a sudden inflation at a very early stage in the big bang.
    c) imply that the universe was once much hotter than it is now.
    d) imply that the universe must be infinite in extent.
    e) show that dark matter must be a small fraction of the total mass of the universe.

22. Active galactic nuclei such as quasars are explained using

    a) gravitational lenses to intensify radiation coming from them.
    b) a massive black hole at the center of a galaxy which has consumed all the matter in its vicinity.
    c) a massive black hole in the center of a galaxy which is being fed large amounts of matter.
    d) an accretion disk around a neutron star.
    e) different lines of sight towards an elliptical galaxy.

23. Astronomers think quasars are very small because

    a) they fluctuate in brightness on short timescales.
    b) their large apparent size is due to magnification by a foreground gravitational lens.
    c) they are so luminous.
    d) they are difficult to detect.

24. Whether the universe is open, closed, or flat depends on the _____of the universe.

    a) rotation rate
    b) temperature
    c) radius
    d) luminosity
    e) density

25. Looking at the Sun-Jupiter system from 1.3 parsecs away (the alpha Cen system), Jupiter would be incredibly faint but still easily detectable using a large telescope. Why, then, would detecting a planet like Jupiter at this distance be so difficult?

    a) Because Jupiter is so much smaller than the Sun.
    b) Shining in reflected light, Jupiter's spectrum is the same as the Sun's.

c) Jupiter will be constantly eclipsed and unobservable.

d) Jupiter's light will be swamped by the relatively immense glare of the Sun.

e) Because Jupiter will be moving too fast to get a good picture of it.

26. The technique of using eclipsing binaries to detect planets will only work for about 1 system out of 1000. Why is this?

a) That's roughly the fraction of stars that don't have spots, and it's nearly impossible to tell an eclipse from a starspot.

b) Only about 1 system in 1000 is expected to have planets large enough to cause detectable eclipses.

c) Only in about 1 system in 1000 do we expect the planet to cause eclipses that have a different spectrum from its central star.

d) Only about 1 system in 1000 is close enough for us to see eclipses.

e) Eclipses can only be seen if you're in the orbital planet of a system, and the chance of this happening is about 1 in 1000.