Astronomy 123
Final Ecamination
December 7, 2011

Name _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. There are 34 multiple choice questions each worth 1 point ---> 34 total points

1) Which of the following can actually escape from inside a black hole's event horizon?   1) _____
   A) very high energy gamma-rays
   B) electrons
   C) quarks
   D) neutrinos
   E) none of the above

2) The Schwarzschild radius for a black hole 10 times the mass of the Sun s: 2) _____
   A) about 30 kilometers.
   B) about 10 kilometers.
   C) about 3 times the size of the Earth.
   D) a little larger than the Sun.
   E) around the size of the Solar System.

3) In the Anthropic Principle,   3) _____
   A) it is stated that our Universe is only universe in existence.
   B) the Universe is considered to be timeless.
   C) closed universes are not possible.
   D) we the observer sit in a preferred position in the Universe.
   E) our view of the Universe is colored by the fact that we are the observer

4) Matter belonging to the Galaxy can be traced out to _____ from the center.   4) _____
   A) 150,000 light years
   B) 1,500,000 light years
   C) 25,000 light years
   D) 6,000 light years
   E) 48,000,000 light years

5) The location of the center of the Galaxy was determined by Shapley from observations of: 5) _____
   A) cepheids in open clusters.
   B) the radio emissions from Sagittarius A.
   C) blue supergiants in the spiral arms.
   D) RR Lyrae variables in globular clusters.
   E) her big-har objects in emission nebule.

6) Which of these techniques has the most promise for detecting MACHOs?   6) _____
   A) tracking down their tidal streams in the halo
   B) seeing transits as they pass in front of background stars' disks
   C) observing duration of their eclipses of normal companions
   D) detecting the X-rays emitted as they trap interstellar matter
   E) observing duration and intensity of gravitational lenses

7) The object located at the center of the Galaxy is believed to be: 7) _____
    A) a hypernova about to happen...be very afraid.
    B) an enormous emission nebula.
    C) a quasar of over a billion solar masses.
    D) a large cluster of very young and massive stars.
    E) a black hole of over 3 million solar masses.

8) What observation of the Galaxy suggests it is much larger than the halo and contains a large   8) _____
amount of matter not in the form of stars?
    A) the rotation curve
    B) motions of the globular clusters
    C) the shape of the spiral arms
    D) infrared observations of the center of the Galaxy
    E) tidal streams in the halo

9) Which relation matches the rotation of a spiral galaxy to its luminosity?   9) _____
    A) the Tully–Fisher Relation
    B) Hertzsprung–Russell diagram
    C) the Chandrasekhar Limit
    D) Hubble's Law
    E) Hubble's Tuning Fork Diagram

10) Using a H_O of 65 km/sec/Mpc, find the distance to a galaxy receding at 6,500 km/sec.   10) _____
    A) one megaparsec
    B) one hundred megaparsecs
    C) 100,000 parsecs
    D) 10,000 parsecs
    E) ten megaparsecs

11) Why do some quasars have red shifts greater than 1?   11) _____
    A) They are very distant, with relativistic red shifts that take into account dilation of
       space–time, as Einstein predicted.
    B) Einstein proved it is impossible to have a redshift greater than 1; these are all due to
       gravitational lensing tricking us.
    C) They are moving towards us, which throws off our spectrometers.
    D) They are made of different elements than any other objects in the universe.
    E) They are made of tachyons and thus are able to move away from us faster than the speed
       of light.

12) What is the most likely source of energy for active galaxies and quasars?   12) _____
    A) collisions of large spiral galaxies
    B) large clusters of very massive, luminous stars
    C) accretion onto a supermassive black hole
    D) numerous supernovae from rapid star formation in young galaxies
    E) a single supermassive, superluminous star

13) Collisions between galaxies can:
    A) cause bursts of star formation as starburst galaxies.
    B) hardly ever occur; like stars, galaxies are far apart, compared to their sizes.
    C) cause both galaxies to collapse into a supermassive black hole.
    D) cause large numbers of stars to collide and explode.
    E) turn irregulars into ellipticals.

13) _____

14) Why are supermassive galaxies often found at the cores of rich galaxy clusters?
    A) They are the result of many galactic mergers; one galaxy growing at the expense of others.
    B) Most of the matter forming the cluster fell into the center to form one large galaxy.
    C) Such a large galaxy attracted smaller galaxies around it to form a cluster.
    D) Large galaxies, passing a cluster, get captured into the center.
    E) Many globular clusters swarmed together to form it.

14) _____

15) The energy radiated from a typical quasar requires that its black hole accrete about:
    A) 1 solar mass per 10,000 years.
    B) 1 solar mass per 100 years.
    C) 1,000 solar masses per year.
    D) 10 solar masses per year.
    E) 1 Jupiter mass per year.

15) _____

16) The look-back time of an object is directly related to its:
    A) mass.
    B) luminosity.
    C) distance.
    D) composition.
    E) size.

16) _____

17) In the Penrose Process, a rotatingblack hole can radiate up to how much total mass-energy?
    A) .7%   B) 29%   C) .08%   D) 59%   E) 1.4%

17) _____

18) Homogeneity and isotropy, taken as assumptions regarding the structure and evolution of the universe, are known as:
    A) Wien's Law.
    B) the Cosmological Principle.
    C) the Grand Unified Theory.
    D) Obler's Paradox.
    E) Hubble's Law.

18) _____

19) _____ is the concept that all large samples of the universe are alike in appearance anywhere in the universe.
    A) Isotropy
    B) Conformity
    C) Universality
    D) Homogeneity
    E) Cosmology

19) _____

20) The redshift of galaxies in the universe is correctly interpreted as: 20) _____
   A) space itself is expanding with time; the wavelengths of photon are stretched while they
      travel through space.
   B) a Doppler shift due to the motions of the galaxies through space.
   C) an "aging" of the light.
   D) the effect of intergalactic dust.
   E) the difference in temperatures of distant and nearby galaxies.

21) The current makeup of the Universe is thought to be   21) _____
   A) 60 % spiral galaxies, 30 % elliptical galaxies, 10 % irreular galaxies
   B) 90 % hydrogen, 10 % helium
   C) 15 % black holes with the rest equally divided between normal stars and dark matter
   D) 73 % dark energy, 23 % dark matter, 4 % normal matter
   E) dominated by the cosmic microwave background radiation

22) The universe has three possible futures. Which one is correct depends only on the average   22) _____
   density of matter in the universe. Why is this?
   A) The density of visible matter must exactly equal the dark force energy.
   B) The density of matter determines the strength of gravity, which decelerates the expansion
      over time.
   C) The density of matter tells astronomers whether new matter is constantly forming, thereby
      producing a steady–state.
   D) The density of matter determines the rate of formation of black holes which will
      eventually collapse the universe.
   E) If the density is sufficiently high, the geometry of space may be curved.

23) What is the meaning of a "closed" universe?   23) _____
   A) The universe will stop expanding in an infinite amount of time.
   B) The universe will expand forever.
   C) The universe is in a steady–state.
   D) The universe will disappear into a white hole in time.
   E) The universe will someday stop expanding and start to collapse.

24) The Universe is currently to thought to have an age of   24) _____
   A) 6.7 billion years
   B) 4.6 billion years
   C) 50.8 billion years
   D) 1.4 billion years
   E) 13.7blllion years

25) Recent work with type I supernovae at great distances suggests the Universe may in fact be   25) _____
   accelerating its expansion:
   A) suggesting that dark energy domiantes the Universe
   B) as a result of the formation of virtual pairs in the vacuum
   C) because of the anti–gravity nature of anti–matter
   D) A & B are both correct
   E) A, B, & C are all correct

26) The Wilkinson Microwave Anisotropy Probe (WMAP) data showed that with very minor   26) _____
   variations, the temperature of the background radiation is exactly:
     A) 4.8 K.   B) 0.23 K.   C) 2.73 K.   D) 1.4 K.   E) 37.8 K.

27) How hot was the universe at time zero?   27) _____
     A) 16, 000 K
     B) 2.73 K
     C) 10^{32} K
     D) 5, 800 K
     E) We have no theory capable to addressing this singularity.

28) Gravity becomes separate from the other forces at the: 28) _____
     A) decoupling Event, about a million years after the Big Bang.
     B) end of electron production, about a minute after creation.
     C) end of the Inflationary Epoch, about 10^{-32} seconds into creation.
     D) beginning of particle production, about .0001 seconds into the universe.
     E) end of the Planck Era, about 10^{-43} seconds after the Big Bang.

29) In the Hubble Tuning Fork diagram for galaxy classification: 29) _____
     A) the categorizations on based on the appearances of the galaxies (their morphology)
     B) the bulges of Sa galaxies are relatively smaller than the bulges of Sc galaxies
     C) Elliptical galaxies of type E5 are more spherical than those of type E0
     D) it is suggested that galaxies evolve from Sc to Sb to Sa to elliptical
     E) All of the above are true statements on the Hubble galaxy classification scheme.

30) The scarcity of what isotope is a critical test of the density of the present cosmos?   30) _____
     A) helium 3   B) lithium 5   C) helium 4   D) deuterium   E) carbon 14

31) Which of these did NOT occur at recombination (decoupling)?   31) _____
     A) Neutral atoms were formed.
     B) Electrons began to orbit protons.
     C) Matter dominated radiation.
     D) The cosmic microwave radiation was released from matter.
     E) The universe became transparent.

32) The "flatness" problem arises because Ω_0 seems remarkably close to: 32) _____
     A) .5, suggesting we are split between open and closed universes.
     B) 2.73 K, in spite of the eddies and turbulence that led to galaxy formation.
     C) one
     D) infinity, suggesting an open universe is the only possible cosmology.
     E) zero curvature, favoring a spherical cosmos.

33) What did the cosmic microwave background tell cosmologists about the early Universe?   33) _____
     A) It suggested that Hawking and Hartle were right in that time in the Universe came into
       existence at the Big Bang.
     B) The Universe did not start as a singularity.
     C) The Universe is actually much younger than indicated by the Hubble time.
     D) Galaxies and clusters of galaxies were already in existence at the time of recombination.
     E) The horizon problem in that the microwave background is almost too isotropic.

34) Of the following, which is not strong evidence for the Big Bang theory?   34) _____
   A) the Hubble law
   B) the Cosmic Microwave Background Radiation (CMBR)
   C) Matter clusters on all scales, drawn together by gravity.
   D) The normal mass of the Universe is roughly 90 % hydrogen and 10 % helium
   E) The redshifts of distant galaxies depend linearly on their distances.

SHORT ANSWER. Write your answer in the space provided or on a separate sheet of paper. There are 6 short answer questions each worth 6 points –––> 36 total points

35) The Drake Equation

   a. Name each of the factors of the Drake equation.

   b. State the rough value for each factor of the Drake Equation and give an indication of how well–known is the factor.

36) Inflation

    a. Relate the inflationary theory to the GUTs. When does inflation occur?

    b. What cosmological mysteries does inflation *solve*?

    c. Choose of your listed mysteries and explain how Inflation resolves the mystery.

37) Galaxies in all directions are observed to be streaming away from us as if we were in the center of the universe.

a. Is this impression consistent with the Cosmological Principle? State why they are or why the two are not consistent.

b. Explain how Hubble expansion is is consistent with the Cosmological Principle, that is, explain how the Hubble expansion that we are not in a preferred location in the Universe.

38) To construct a Hubble diagram, we need to know recessional velocities and distances for a sample of galaxies.

a How are recessional velocities determined?

b. How are the distances of the galaxies estimated?

39) a. What is the name for the puzzle of the darkness of the night sky?

    b. How does the Big Bang resolve this issue?

40) At present the Universe is expanding, but we are not certain if this expansion will continue forever, come to a stop, or if the universe will ultimately collapse back into itself. Describe two observational tests which have been applied to test among these three possibilities?

    a.

b.

1) E
2) A
3) E
4) A
5) D
6) E
7) E
8) A
9) A
10) B
11) A
12) C
13) A
14) A
15) D
16) C
17) B
18) B
19) D
20) A
21) D
22) B
23) E
24) E
25) D
26) C
27) E
28) E
29) A
30) D
31) C
32) C
33) E
34) C