

Name \_\_\_\_\_

**MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. Each multiple choice question is worth 2 points for 2 x 40 = 80 total points**

- 1) Which of the following paraphrases Hubble Law? 1) \_\_\_\_\_
  - A) The more distant a galaxy is, the younger it appears.
  - B) The greater the distance to a galaxy, the greater its redshift.
  - C) The older the galaxy appears to us, the more luminous it is.
  - D) The faster the galaxy spins, the more massive and luminous it is.
  - E) The greater the distance to a galaxy, the fainter it is.
  
- 2) A galaxy is at a distance of one billion light years. Which of the following is true? 2) \_\_\_\_\_
  - A) We see the galaxy the way it was when the universe was one billion years old.
  - B) We see what our galaxy will be like in one billion years.
  - C) We see the galaxy the way it was one billion years ago.
  - D) We have no knowledge of anything at that distance.
  - E) We see the galaxy the way it will be in one billion years.
  
- 3) The presence of free oxygen in an atmosphere is a strong indicator of 3) \_\_\_\_\_
  - A) dark energy generation
  - B) global warming
  - C) a star in decline
  - D) a nearby black hole
  - E) biology
  
- 4) The Copernican belief states that 4) \_\_\_\_\_
  - A) the Universe is homogeneous but not isotropic
  - B) we occupy a preferred place in the Universe
  - C) we do not occupy a preferred place in the Universe
  - D) the Universe is isotropic but not homogeneous
  - E) the CMBR is expected to show large variations across the Universe
  
- 5) The *Big Freeze* is: 5) \_\_\_\_\_
  - A) a time when the temperature of the Universe reaches  $10^{-30}$  Kelvin
  - B) when spontaneous production of matter/anti-matter twins continuously occurs
  - C) a rapid increase in the size of the Universe causes it to cool rapidly
  - D) the era when black holes dominate the Universe
  - E) when the Universe freezes and all motion stops

- 6) The distribution of \_\_\_\_\_ showed Shapley we were no where near the center of the Milky Way galaxy. 6) \_\_\_\_\_  
 A) hot, luminous stars  
 B) halo black holes  
 C) supernova remnants  
 D) globular clusters  
 E) other spiral galaxies
- 7) Cosmology is: 7) \_\_\_\_\_  
 A) the study of the structure and evolution of the universe  
 B) the study of the origin of materials which make up the universe  
 C) the study of the origins and evolution of life and planets in the universe  
 D) the study of the life cycles of the objects and materials which makeup the universe  
 E) the study of the ultimate fate of the universe, that is, the study of the future of the universe.
- 8) Current observations lead astronomers to propose that the expansion of the Universe started 8) \_\_\_\_\_  
 A) 13.7 billion years ago  
 B) 22 billion years ago  
 C) 4.6 billion years ago  
 D) its current cycle 13.7 billion years; the current cycle is the third such in the lifetime of the Universe  
 E) 27.4 billion years ago
- 9) The Anthropic principle states: 9) \_\_\_\_\_  
 A) what we can expect to observe cannot be restricted by the conditions necessary for our presence as observers  
 B) the existence of humans and other animals shows that there is a required specific makeup of our Universe  
 C) what we can expect to observe as the properties of the Universe is restricted by the conditions necessary for our presence as observers  
 D) that the conditions that make the Earth suitable for life are produced by the existence of life.  
 E) we, as humans, are more evolved than any other animal.
- 10) Without the greenhouse effect operating in our atmosphere, 10) \_\_\_\_\_  
 A) the ice in the polar regions would have melted long ago.  
 B) we would not have to worry about any warming problems in the future.  
 C) the Earth would have become much more like Venus long ago.  
 D) Earth would have an average temperature of -23 degrees Celsius.  
 E) the ozone layer would not be weakening.
- 11) What is the difference between *Universe* (with a capital U) and *universe*? 11) \_\_\_\_\_  
 A) *Universe* refers to the ideal universe, the one that exists only in theory  
 B) There is none, they are interchangeable  
 C) Cosmologists refer to the *Universe* while *universe* is used by average Joes.  
 D) *universe* refers to universes in general while *Universe* refers to the one in which we live  
 E) The use of a capital U in universe is used by astrologers and is not a scientific concept

- 12) The Drake equation calculates N. What is N? 12) \_\_\_\_\_  
A) the number of stars with habitable planets  
B) the number of intelligences in the entire universe  
C) the number of planets with life in the universe  
D) the number of planets in just our galaxy  
E) the number of technical civilizations in our galaxy presently
- 13) When will (did) the Big Rip occur? 13) \_\_\_\_\_  
A) It will occur in 13.7 billion years  
B) It occurred 13.7 billion years ago.  
C) It will occur in 100 billion years.  
D) It will occur in 22 billion years  
E) It occurred 378,000 years after the birth of the Universe.
- 14) The first tests to demonstrate the possibility of that amino acids could be produced by chemical evolution in an atmosphere similar to that of the primeval Earth were done in 1953 by: 14) \_\_\_\_\_  
A) Frank Drake.  
B) Miller and Urey.  
C) Wilson and Penzias.  
D) Carl Sagan.  
E) Friedman and Lemaitre
- 15) In terms of its thick and chemically active atmosphere of methane and other hydrocarbons, which Saturnian moon merited a visit by the Huygens probe in 2005? 15) \_\_\_\_\_  
A) Ganymede  
B) Enceladus  
C) Titan  
D) Io  
E) Europa
- 16) Gravity becomes separate from the other forces at the: 16) \_\_\_\_\_  
A) end of the Inflationary Epoch, about  $10^{-32}$  seconds into creation.  
B) end of electron production, about a minute after creation.  
C) beginning of particle production, about .0001 seconds into the universe.  
D) end of the Planck Era, about  $10^{-43}$  seconds after the Big Bang.  
E) decoupling Event, about a million years after the Big Bang.
- 17) Which of the following factors from the Drake equation has a value that is not at all known? 17) \_\_\_\_\_  
A) fraction of life-bearing planets on which intelligence evolves  
B) the number of stars in a galaxy  
C) average lifetime of a technological civilization  
D) rate of star formation in a galaxy like ours  
E) fraction of stars having a planetary system

- 18) The Wilkinson Microwave Anisotropy Probe (WMAP) data says that the Universe is 18) \_\_\_\_\_  
A) 27% matter and 73% dark energy.  
B) less detailed than the discovery observations of Penzias and Wilson  
C) completely opposite the expectations of the inflationary epoch.  
D) flat, and static in reality.  
E) open, with density 2 to 3 times larger than the critical density.
- 19) Today, we have discovered 19) \_\_\_\_\_  
A) two extra-solar planetary systems which harbor earth-like planets with clear evidence of seasonal variation of planet life  
B) three extra-solar planets with oxygen in their atmospheres  
C) that nearly all stars without companion stars show planetary systems nearly identical to the Solar System in form and number of planets  
D) more than 700 extra-solar planets  
E) only one extra-solar planetary system which harbors a planet with a nitrogen/oxygen atmosphere
- 20) What is a "habitable zone"? 20) \_\_\_\_\_  
A) a region beneath the ice of Europa where water is liquid  
B) a zone of habitability for planets orbiting their stars  
C) a zone of habitability in temperature regions on earthlike planets  
D) a zone of habitability within the dense atmosphere of the planet Jupiter  
E) a zone of habitability for stars orbiting the centers of active galaxies
- 21) From the Sun, what is the distance to the Galaxy's center? 21) \_\_\_\_\_  
A) around 8,000 light years  
B) almost 2.2 million light years  
C) roughly 26,000 light years  
D) a little less than 25 billion light years  
E) it is uncertain, but must be greater than 300,000 light years
- 22) Which of the following can actually escape from inside a black hole's event horizon? 22) \_\_\_\_\_  
A) electrons  
B) neutrinos  
C) very high energy gamma-rays  
D) gravitons  
E) none of the above
- 23) The temperature of the Cosmic Microwave Background radiation (CMBR) is: 23) \_\_\_\_\_  
A) 3,000 K      B) 100 K      C) 5,800 K      D) 2.73 K      E) 16,000 K
- 24) Of the normal elements around us, the Big Bang produced: 24) \_\_\_\_\_  
A) all elements up to iron.  
B) only hydrogen.  
C) none, only energy.  
D) all elements in much their present proportions.  
E) hydrogen and helium.

- 25) The Schwarzschild radius for a black hole the same mass as the Sun is \_\_\_\_\_. The Schwarzschild radius is the radius of the Event Horizon of a black hole. 25) \_\_\_\_\_
- A) about three kilometers.
  - B) about three meters.
  - C) about the size of the Earth.
  - D) larger than our Sun.
  - E) about the size of Jupiter.
- 26) Which of these seems the best present answer to the horizon and flatness problems? 26) \_\_\_\_\_
- A) the inflationary epoch
  - B) symmetry in creation of particles and antiparticles
  - C) Dark Energy speeds the universe on out to infinity.
  - D) The superforce rules creation.
  - E) the GUT theory
- 27) ALH 84001 is a famed and very controversial meteorite with hints that life might have existed on: 27) \_\_\_\_\_
- A) Mars.                      B) Enceladus.                      C) Europa.                      D) Venus.                      E) Titan.
- 28) The critical temperature for nucleosynthesis to begin was reached, 28) \_\_\_\_\_
- A) after the deuterium bottleneck was *broken*
  - B) after recombination took place
  - C) around when matter started to dominate the Universe
  - D) just after the start of the Big Rip
  - E) just after the initial production of lithium
- 29) In terms of Friedman models for the Universe, current observations suggest that we live in a 29) \_\_\_\_\_
- A) closed Universe
  - B) open Universe
  - C) flat Universe
  - D) oscillating Universe
  - E) Universe in a multiverse of universes
- 30) The Cosmological Principle states 30) \_\_\_\_\_
- A) the Universe appears homogeneous and isotropic for all observers
  - B) that what we can expect to observe is restricted by the conditions necessary for our presence as observers
  - C) that there are preferred observing locations and times in the Universe
  - D) that the Universe was much smaller and hotter in the past and has since been expanding
  - E) the Universe is bland in appearance and static in nature
- 31) Einstein's suggestion of the Cosmological Constant was based on his 31) \_\_\_\_\_
- A) belief of an expanding Universe
  - B) belief in the Big Bang theory
  - C) confidence in his General Theory of Relativity
  - D) belief in a static universe and the perfect Cosmological Principle
  - E) resolution of Olbers' paradox

- 32) Which of these does Mars NOT have to help its case of past or present life? 32) \_\_\_\_\_  
A) occasional water flows, and past records of much larger ones  
B) a protective ozone layer  
C) an abundant source of water held in its northern polar cap  
D) carbon dioxide to provide some greenhouse warming  
E) a favorable distance from the Sun
- 33) What molecule dominates the atmospheres of Mars and Venus 33) \_\_\_\_\_  
A) carbon dioxide  
B) methane  
C) nitrogen molecules  
D) water  
E) perchlorates
- 34) Most experiments designed to search for extraterrestrial life are based on ideas that come from 34) \_\_\_\_\_  
A) the concept of LAWKI  
B) the anthropomorphic principle  
C) the Gaia hypothesis  
D) the belief that life forms only on planets with large moons  
E) the predications of the Drake equation
- 35) The first attempt to map the Galaxy via star counts was performed by: 35) \_\_\_\_\_  
A) William Herschel in the late eighteenth century.  
B) Edwin Hubble with the new 100" Mt. Wilson telescope in the 1930s.  
C) the ancient Greek, Ptolemy, approximately 2,000 years ago.  
D) Vesto M. Slipher in the early 1900s.  
E) Harlow Shapley with the RR Lyrae variables in 1920.
- 36) What are the four known forces in the Universe today? 36) \_\_\_\_\_  
A) tides, gravity, electrical, and nuclear  
B) atomic, nuclear, electrical, and gravity  
C) strong, weak, gravity, and electrical  
D) strong, compression, weak, and nuclear  
E) GUT, superforce, strong, and electrical
- 37) The crossover point from radiation to matter domination occurred: 37) \_\_\_\_\_  
A) when the strong force separated from the other two forces.  
B) with the creation of electrons and positrons at about  $6 \times 10^9$  K.  
C) with the emission of the cosmic background radiation.  
D) about 50,000 years after the Big Bang, at a temperature of about 16,000 K.  
E) with the creation of neutrons and protons, at about  $10^{13}$  K.
- 38) The existence of water on Mars is strongly supported by 38) \_\_\_\_\_  
A) the northern polar cap  
B) glaciers  
C) fog  
D) only A and B are evidence for water on Mars  
E) A, B, and C are all evidence for water on Mars

- 39) The standard candles that allowed us to determine that the expansion rate of the Universe was increasing were 39) \_\_\_\_\_
- A) classical Cepheid stars
  - B) the globular clusters
  - C) mundane stars, such as the Sun and Proxima Centauri
  - D) supermassive black holes
  - E) Type Ia supernovas

- 40) The era in which the four forces of the Universe were unified was the 40) \_\_\_\_\_
- A) Planck era
  - B) the GUT era
  - C) the quark era
  - D) the lepton era
  - E) the nuclear era

**SHORT ANSWER. Write your answer in the space provided. Each question carries equal weight. This section is worth 88 total points**

- 41) List the three principal observations which led to the development and acceptance of the Big Bang Theory and then explain why each offers strong support for the Big Bang Theory.

42) If life redevelops on Earth in 100 billion years, describe how the universe would appear to this observer. Explain why the observations would differ from those made by astronomers today. Is the Principle of Mediocrity likely to be the guiding principle? If so, why. If not, why not. Briefly discuss whether this inspires confidence or undermines your confidence as to our ability to model the Universe?



43) Describe the Fermi Paradox. Discuss possible resolutions for the Fermi Paradox. Support your suggested solutions with explicit arguments backed up by data of some sort.

44) Describe the Faint Young Sun Problem and present a resolution for the Faint Young Sun Problem.



## Answer Key

Testname: ASTR123\_FINAL\_SPR2013

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