

NAME _____

Test 1

Astronomy 123

2013 May 1

There are 15 multiple choice questions each worth 2 points, and 5 short answer questions each worth 14 points. The exam is scored for a total of $15 \times 2 \text{ points} + 5 \times 14 \text{ points} = 100 \text{ points}$.

MULTIPLE CHOICE—Choose the best answer

1. Of the following, the most important criterion for determining whether a theory is scientific or is not scientific, is that _____.
 - a. the theory must be testable through experiment
 - b. a majority of scientists must agree that the theory is correct
 - c. the theory must be based entirely on what is known and facts that have have been shown to be true from experiment
 - d. the theory must pass the majority of tests posed to it. A scientific theory need not pass all tests posed to it.
 - e. the theory must be useful in the sense that it can be applied to advance societal goals

2. An important assumption made by Friedman when he developed his models for expanding universes was that _____.
 - a. the Perfect Cosmological Principle was valid.
 - b. the Principle of Mediocrity was not a law and so could be ignored.
 - c. the Anthropic Principle removed the necessity of explaining the beginning of the universe.
 - d. the Cosmological Principle was valid.
 - e. the Milky Way was at the center of the Universe

3. Based on current observations, the Universe is estimated to be _____.
 - a. 8 to 9 billion years old
 - b. 13.7 billion years old
 - c. 11 to 18 billion years old
 - d. 4.6 billion years old
 - e. ageless, it has always existed

4. Today, the Universe is dominated by _____.
 - a. hydrogen and helium
 - b. dark matter
 - c. normal matter
 - d. radiation
 - e. dark energy

5. The Cosmic Microwave Background (CMBR) _____.
 - a. is relic radiation of the Big Bang itself
 - b. has temperature 2.7 Kelvin with only small differences from 2.7 Kelvin found when looking in different directions on the sky
 - c. shows very small temperature variations above and below 2.7 Kelvin, variations which strongly support the existence of dark matter.

- d. Only A and B are correct statements about the CMBR.
 - e. A, B, and C are all correct statements about the CMBR.
6. The Sun is about _____ from the center of the Milky Way galaxy.
- a. 100,000 light years
 - b. 8,600 light years
 - c. 27,000 light years
 - d. 300,000 light years
7. Which of the following is **not** one of the fundamental forces in the current Universe?
- a. the strong force
 - b. the weak force
 - c. the electromagnetic force
 - d. the GUT force
 - e. the gravitational force
8. The rapid expansion of the Universe which occurred around 10^{-34} seconds after the birth of the Universe, _____ .
- a. took place when the Planck era ended and the GUT era began
 - b. happened as a result of inflation
 - c. took place at the start of the dark energy era
 - d. happened just before the anti-matter/matter asymmetry was resolved
 - e. strongly supports the Anthropic Principle
9. The redshifts of distant galaxies _____.
- a. have shown that our Universe is only one of many universes, each of the other universes moving away from us according to their distance
 - b. have shown that the Universe has stopped expanding and is now starting to collapse
 - c. have shown that the Universe started its evolution in a huge explosion centered on the Milky Way galaxy
 - d. arise simply because the Universe is expanding in size
 - e. are produced right after inflation has ended
10. When we observe a galaxy which is 1 billion light years from the Earth, _____.
- a. we see the galaxy as it was roughly 1 billion years ago
 - b. it is proven that the Anthropic Principle cannot be correct
 - c. we show that the Principle of Mediocrity is invalid
 - d. we see what the Milky Way galaxy will look like in 1 billion years
 - e. we see the galaxy as it will be in 1 billion years
11. If we find that the interior angles of a triangle add up to less than 180° , _____.

- a. we deduce that the Universe will expand forever
 - b. we conclude that the Cosmological Principle is not valid
 - c. we deduce that the Universe is closed
 - d. we understand why the Greeks did not detect parallax
 - e. we surmise that the Multiverse theory is correct in that this is strong evidence that we just collided with another universe
12. Based on the Hubble Law, a galaxy whose redshift is twice as large as the redshift for the distant galaxy M87 in the Virgo cluster of galaxies _____.
- a. is at twice the distance from the Milky Way as is M87
 - b. is four times as far away from the Milky Way as is M87
 - c. is at half the distance from the Milky Way as is M87
 - d. is at one-fourth the distance from the Milky Way as is M87
13. Shapley found the location of the Sun in the Milky Way galaxy through studies of _____.
- a. the distribution of dark energy
 - b. globular clusters
 - c. the ages of stars
 - d. the distribution of the bright stars around the Sun
 - e. the parallax of nearby stars
14. An anti-matter particle _____.
- a. annihilates (turns to energy) when it meets its matter twin
 - b. is the same as its matter twin except for its electrical properties
 - c. has recently been shown to be the dark energy particle
 - d. Only A & B are correct statements about anti-matter.
 - e. A, B, & C are correct statements about anti-matter.
15. Current data suggests that the make-up of our Universe at the present time is _____.
- a. nearly 90 % dark matter, 10 % dark energy, and < 1 % normal matter
 - b. primarily pure energy, that is, radiation, with a smattering of dark energy, and matter thrown into the mix
 - c. around 70-73 % dark energy with the rest divided between dark matter and normal matter
 - d. 70 % normal matter and 30 % anti-matter
 - e. almost 99.99 % anti-matter, the remaining < 0.01 % are elements heavier than helium

2. Cosmological Principles

a. State the Principle of Mediocrity.

b. State the Cosmological Principle and the Perfect Cosmological Principle.

c. Describe how Einstein's belief in the Perfect Cosmological Principle led him astray when he was thinking about models for the Universe.

3. The Horizon Problem

- a. Briefly describe the Horizon Problem. Include how the CMBR's properties lead to the Horizon Problem.

- b. Describe how inflation leads to a solution of the Horizon Problem.

5. Olbers' Paradox

- a. Briefly describe Olbers' Paradox. Be sure to include the assumptions which underlie the reasoning which leads to Olbers' Paradox

- b. How is Olbers' Paradox resolved? What assumptions must be modified to resolve Olbers' Paradox? Explicitly relate how the Big Bang leads to the resolution of Olbers' Paradox.