

Chapter 15

Cosmology:

Will the universe end?

1. Who first showed that the Milky Way is not the only galaxy in the universe?

- a. Kepler
- b. Copernicus
- c. Newton
- d. Hubble
- e. Galileo

Ans: d

Link To: [Galaxies](#)

Difficulty Level: Easy

2. The big bang theory and the theory of the steady state universe differ

- a. because only the big bang theory states that the universe is expanding.
- b. because only the steady state theory states that the universe is expanding.
- c. in that only the steady state theory lacks a specific beginning for the universe.
- d. in that only the steady state universe incorporates an idea about the missing dark matter.
- e. only in name.

Ans: c

Link To: [The Big Bang](#)

Difficulty Level: Easy

3. When astronomers look out at our universe, they see all

- a. other planets moving away from us.
- b. other galaxies moving away from us.
- c. asteroids moving toward us.
- d. supernovas moving away from us.
- e. other galaxies moving toward us.

Ans: b

Link To: [The Redshift and Hubble's Law](#)

Difficulty Level: Easy

4. Which of the following was not a contribution to cosmology by Edwin Hubble?

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- a. the proof that there are other galaxies
- b. the idea that far galaxies are moving faster than those near
- c. the discovery of the cosmic red shift
- d. the realization that evidence for the big bang can come from studies of abundances of chemical elements
- e. All of these were contributions made by Hubble.

Ans: d

Link To: [The Redshift and Hubble's Law](#)

Difficulty Level: Easy

5.Hubble's law tells us that

- a. the distance to other galaxies can be measured by calculating the blue shift of the light we receive from them.
- b. the rate at which a galaxy recedes from the Earth is proportional to the square of the distance from the Earth.
- c. the rate at which a galaxy advances toward the Earth is proportional to its distance from the Earth.
- d. the distance to other galaxies can be measured by calculating the red shift of the light we receive from them.
- e. the rate at which a galaxy moves is the Hubble constant.

Ans: d

Link To: [The Redshift and Hubble's Law](#)

Difficulty Level: Easy

6.The most recent "freezing" of the universe involved the creation of

- a. nuclei.
- b. atoms.
- c. elementary particles.
- d. quarks.
- e. molecules.

Ans: b

Link To: [The Evolution of the Universe](#)

Difficulty Level: Easy

7.The redshift surveys of the 1980s

- a. determined the velocity of superclusters.
- b. were significant in calculating Hubble's constant.

- c. measured the distance to thousands of galaxies.
- d. definitively proved the big bang theory.
- e. provided a foundation for planetary exploration.

Ans: c

Link To: The Big Bang

Difficulty Level: Easy

8. The discovery of a cosmic microwave background
- a. supported the idea of a steady state universe.
 - b. showed that the universe has a constant heat source.
 - c. proved that matter in the universe is grouped in superclusters.
 - d. gave support to the big bang theory.
 - e. indicated that supernovas produced all known elements.

Ans: d

Link To: The Big Bang

Difficulty Level: Easy

9. What were the first three elements formed in the big bang?
- a. hydrogen, lithium, and helium
 - b. hydrogen, oxygen, and helium
 - c. helium, oxygen, and carbon
 - d. carbon, oxygen, and deuterium
 - e. helium, oxygen, lithium

Ans: a

Link To: The Big Bang

Difficulty Level: Easy

10. According to the current ideas about the origin of the universe, which one of the following forces separated at 10^{-43} seconds?
- a. the gravitational force
 - b. the electromagnetic force
 - c. the strong force
 - d. the weak force
 - e. All of these forces froze out at the same time.

Ans: a

Link To: The Evolution of the Universe

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Difficulty Level: Easy

11. Which wavelength of radiation is associated with our expanding universe?

- a. 7.35 nanometers
- b. 7.35 millimeters
- c. 7.35 centimeters
- d. 7.35 meters
- e. 7.35 kilometers

Ans: c

Link To: The Evolution of the Universe

Difficulty Level: Easy

12. Which of the following is constructed completely from atoms made during the big bang?

- a. a leaf
- b. the air you are breathing
- c. bone
- d. a cinder block
- e. None of the above is formed completely from atoms created during the big bang.

Ans: e

Link To: The Big Bang

Difficulty Level: Easy

13. According to the big bang theory, what accompanied the freezing of the universe at 10^{-35} second after time zero?

- a. Antimatter was eliminated.
- b. All four fundamental forces were unified.
- c. Stable nuclei formed.
- d. There was a short period of inflation.
- e. The strong force separated from the weak force.

Ans: d

Link To: The Evolution of the Universe

Difficulty Level: Easy

14. At what point after the big bang did the elementary particles form?

- a. 10^{-43} second

- b. 10^{-35} second
- c. 10^{-5} second
- d. three minutes
- e. 500,000 years

Ans: c

Link To: The Big Bang

Difficulty Level: Easy

15. What is the basis for evidence supporting the theory of an open expanding universe?
- a. the laws of gravity
 - b. the universe's mass
 - c. the proportion of dark matter
 - d. a newly discovered supernova
 - e. all of the above

Ans: e

Link To: The Evolution of the Universe

Difficulty Level: Easy

16. Because of research with high energy particle accelerators, scientists have direct experimental checks for the evolution of the universe back to
- a. 10^{-43} second after the big bang.
 - b. 10^{-35} second from time zero.
 - c. 10^{-10} second from the beginning.
 - d. three minutes after the big bang.
 - e. one million years following the origin.

Ans: c

Link To: The Evolution of the Universe

Difficulty Level: Easy

17. Which statement about dark matter is accepted by most astronomers?
- a. Dark matter is missing from the Milky Way.
 - b. Dark matter exerts centrifugal forces on antimatter.
 - c. Dark matter emits leptons.
 - d. Dark matter interacts with ordinary matter through a gravitational force.
 - e. all the above

Ans: d

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Link To: The Evolution of the Universe

Difficulty Level: Easy

18. What experimental evidence supports the big bang theory?

- a. universal contraction
- b. creationism
- c. cosmic microwave radiation
- d. abundance of lithium, hydrogen, and helium
- e. c and d

Ans: e

Link To: The Big Bang

Difficulty Level: Easy

19. Antimatter is fairly rare in the universe because

- a. antimatter is dark matter that is very difficult to detect with today's technology.
- b. cosmic microwave background radiation absorbs antimatter in space.
- c. antimatter is a short-lived transient state for quarks.
- d. laboratory research indicates that matter was more plentiful in the early and annihilated the antimatter.
- e. each galaxy produces a specific type of matter, according to Hubble's law.

Ans: d

Link To: The Evolution of the Universe

Difficulty Level: Easy

20. The rate at which new stars are formed

- a. has been constant since the big bang.
- b. was ten times higher seven billion years ago.
- c. was ten times slower seven billion years ago.
- d. cannot be calculated with current technology.
- e. has varied randomly since the big bang.

Ans: b

Link To: Galaxies

Difficulty Level: Easy

21. Which of the following describe a quasar?

- a. highly energetic
- b. dark matter
- c. compressed to the size of the Earth
- d. part of a supercluster
- e. all of the above

Ans: a

Link To: Galaxies

Difficulty Level: Easy

22. Before the first stable nuclei were formed, what was the makeup of the universe?

- a. hydrogen and helium
- b. elementary particles
- c. atoms
- d. molecules
- e. all of the above

Ans: b

Link To: The Big Bang

Difficulty Level: Easy

23. Evidence for the big bang includes the

- a. observation that the universe is expanding.
- b. independent evidence that microwave radiation is coming from all directions in space.
- c. fact that the average temperature of the universe 2.7 Kelvin.
- d. abundance of light elements.
- e. all of the above

Ans: e

Link To: The Big Bang

Difficulty Level: Easy

24. How far away is a galaxy that is moving away from Earth at 100,000 km/s? Assume 50 km/s Mpc for the Hubble constant.

- a. 2000 Mpc
- b. more than 6 light years
- c. 8000 Mpc
- d. more than 4 light years
- e. a and b

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Ans: e

Link To: The Redshift and Hubble's Law

Difficulty Level: Easy

25. Most galaxies are spiral galaxies.

Ans: True

Link To: Galaxies

Difficulty Level: Easy

26. Matter in the universe is concentrated in superclusters on the surfaces of huge empty spaces.

Ans: True

Link To: The Big Bang

Difficulty Level: Easy

27. The more distant a galaxy is from Earth, the slower it moves away from Earth.

Ans: False

Link To: The Redshift and Hubble's Law

Difficulty Level: Easy

28. The universe began as a single point and has been expanding for 16 billion years.

Ans: True

Link To: The Big Bang

Difficulty Level: Easy

29. Galaxies move in relation to other galaxies like electrons move within an atom.

Ans: False

Link To: The Redshift and Hubble's Law

Difficulty Level: Easy

30. Hubble's universal expansion theory was the first theory of the universe to incorporate the idea of expansion.

Ans: False

Link To: [The Redshift and Hubble's Law](#)

Difficulty Level: Easy

31. The average temperature of the universe is near absolute zero.

Ans: True

Link To: [The Big Bang](#)

Difficulty Level: Easy

32. Elements with more than three protons in their nucleus were formed in stars, not during the big bang.

Ans: True

Link To: [The Big Bang](#)

Difficulty Level: Easy

33. Scientists believe they have located the center of the universe.

Ans: False

Link To: [The Big Bang](#)

Difficulty Level: Easy

34. Gravity is the only force we know of that is capable of ending the expansion of the universe.

Ans: True

Link To: [The End of the Universe](#)

Difficulty Level: Easy

35. When the first nuclei were formed, the universe was mostly filled with plasma.

Ans: True

Link To: [The Big Bang](#)

Difficulty Level: Easy

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36. Scientists have combined the weak and the electromagnetic forces using the technology of high-energy physics.

Ans: True

Link To: [The Evolution of the Universe](#)

Difficulty Level: Easy

37. Scientists now believe that 90% of the matter in the universe is made of dark matter.

Ans: True

Link To: [The Evolution of the Universe](#)

Difficulty Level: Easy

38. A closed universe will slow down but never quite stop expanding.

Ans: False

Link To: [The End of the Universe](#)

Difficulty Level: Easy

39. Inflationary theories all agree that since its origin the universe has expanded at a uniform rate.

Ans: False

Link To: [The Evolution of the Universe](#)

Difficulty Level: Easy

40. Why do scientists believe that dark matter does not interact through the electromagnetic force?

- a. because, if it did, it would absorb or emit photons
- b. because it exists too far out into space
- c. it exerts no gravitational pull on other matter
- d. there is too little of it to exert an electromagnetic force
- e. all of the above

Ans: a

Link To: [The Evolution of the Universe](#)

Difficulty Level: Medium

41. In what way is the Milky Way a typical galaxy?

Ans: Spiral, has black hole at center.

Link To: Galaxies

Difficulty Level: Medium

42. How do we know the Milky Way is a spiral galaxy?

Ans: This has been determined through the study of Doppler shifts and Cepheid variable stars.

Link To: Galaxies

Difficulty Level: Medium

43. In the night sky the Milky Way appears as a band of stars across the night sky. How does this fit with the model of a spiral galaxy?

Ans: In a spiral galaxy the stars should be flattened into a disk and should appear as a strip of stars as viewed on end.

Link To: Galaxies

Difficulty Level: Medium

44. Astronomers estimate there is something on the order of 100 billion galaxies in the observable universe. How are such numbers generated? How long would it take to count to 100 billion at the rate of one number per second? Does this suggest that anyone has actually counted the galaxies?

Ans: Numbers are generated statistically; it would take over 3000 years to count the galaxies.

Link To: Galaxies

Difficulty Level: Medium

45. Make a case for the ultimate fate of the universe: a closed, an open, or a flat universe.

Ans: Answers will vary, but in essence, it depends on the rate of expansion, and the amount of mass and/or dark matter/energy in the universe.

Link To: The End of the Universe

Difficulty Level: Medium

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46. A popular rock song of the 1960s proclaimed, “We are stardust . . . billion year old carbon...” Was the band correct about this? Why or why not?

Ans: Yes, all the chemical elements on the periodic table come from the big bang and the life cycle of stars.

Link To: [The Big Bang](#)

Difficulty Level: Medium

47. In what way are dark matter and dark energy related?

Ans: Answers will vary, however dark matter appears to be a gravitational tug on galaxies; dark energy appears to account for the acceleration of the universe.

Link To: [The Evolution of the Universe](#)

Difficulty Level: Medium

48. What would happen to the age of the universe if Hubble’s constant changes with future observations?

Ans: If it increases, the universe will be older; if it decreases, the universe will be younger than current calculations.

Link To: [The Redshift and Hubble’s Law](#)

Difficulty Level: Medium

49. Why was the existence of other galaxies in the universe demonstrated when Hubble measured the distance to the Andromeda nebula?

Ans: The Andromeda nebula was so far away (2 million light-years) that Hubble knew it must be outside the Milky Way galaxy, which is only 100,000 light-years across.

Link To: [The Redshift and Hubble’s Law](#)

Difficulty Level: Hard

50. How did scientists calculate the value of Hubble’s constant?

Ans: Scientists, including Hubble, plotted the velocity of the recession of many galaxies (using redshift data) against their respective distances from Earth (measured by Cepheid variables). The slope of the straight line coming closest to all the data points is the best estimate of Hubble’s constant.

Link To: The Redshift and Hubble's Law
Difficulty Level: Hard

51. What are scientists trying to discover when they make "red shift surveys" of the sky?

Ans: Astronomers making these surveys are looking at distant galaxies and determining the distance these galaxies are from the Earth by the rate at which these galaxies are moving away from us on Earth. The phenomenon is similar to the Doppler effect for sound waves.

Link To: The Redshift and Hubble's Law
Difficulty Level: Hard

52. Place the celestial objects in order by size from planet being the smallest to supercluster being the largest. How do astronomers know "for sure" our position in the universe?

Ans: Answers will vary but must include: Earth, the Sun, a star that can become a supernova, the Milky Way, Local Group, a supercluster. We know our position through observations and calculations of our relative position other celestial objects.

Link To: Galaxies
Difficulty Level: Hard

53. Explain the phrase "ripples at the beginning of time" associated with dark matter theories.

Ans: The effect of an unseen gravitational force on hydrogen in space is theorized to be "dark matter." If this dark matter were organized in clumps at the beginning of the universe, luminous matter would be separated to create the structure of the universe we see today.

Link To: The Big Bang
Difficulty Level: Hard

54. Why are changes of state in the early universe referred to as "freezings?"

Ans: Freezings refer to dramatic changes in the fabric of the universe as it expanded and cooled. Each freezing was a crucial transition, first of forces, then of particles.

Link To: The Evolution of the Universe
Difficulty Level: Hard

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55. What is the significance of the K_L^0 particle discovered by physicists?

Ans: K_L^0 is a particle that decays more often into matter than antimatter. As a consequence, the matter-antimatter annihilation left residual matter in the universe after the big bang. This explains why there is so little antimatter in the universe.

Link To: The Evolution of the Universe

Difficulty Level: Hard

56. How might scientists tell if the universe started to contract?

Ans: One way would be that scientists would observe light emitted from nearby galaxies shifted toward the short wavelengths (for example “blue shifted”) in the electromagnetic spectrum, compared to Earth.

Link To: The Redshift and Hubble’s Law

Difficulty Level: Hard

57. What significance do scientists attach to the fact that some regions of the sky emit microwave background radiation at slightly higher temperatures than other regions?

Ans: Higher temperatures could only be emitted from regions in space that are more dense than the adjacent regions. Thus these areas appear to mark areas where atoms are first being collected into luminous matter. The data suggest that dark matter pulled visible matter into clumps soon after atoms started to form.

Link To: The Big Bang

Difficulty Level: Hard

58. Compare the future for the three theories of the universe: flat, open, and closed.

Ans: An open universe will expand forever because it does not have enough matter to reduce the speed or reverse the direction of the expanding universe. A closed universe has sufficient matter to reverse the expansion and will eventually fall back on itself. A flat universe will simply halt its expansion after an infinite time.

Link To: The Big Bang

Difficulty Level: Hard

59. What new evidence has led to wider acceptance of the open universe theory?

Ans: Astronomers recently reported that using a new standard candle (Type 1a supernova) they were able to measure distances to galaxies at the outer limits of the universe. Comparing light from these galaxies over billions of years, the astronomers believe that the universe is continuing to expand, which is consistent with the open universe theory.

Link To: The Big Bang

Difficulty Level: Hard

60. Review the ideas about the universe embraced by the Greeks, the medieval scholars, Newton, and Hubble. How are these ideas still changing?

Ans: Answers will vary but should include the idea of an earth centered universe, then sun-centered universe with Newton's laws acting the same no matter where they were located to Einstein's theories of energy/matter/time, to Hubble's discovery of other galaxies.

Link To: The Redshift and Hubble's Law

Difficulty Level: Hard

61. Compare the expanding-balloon analogy of the universe with the raisin-bread dough analogy. What are their common points? At what point does each analogy fall apart?

Ans: Common points are the parts moving away from a central event. The raisin-bread analogy falls apart in that there isn't enough dough between raisins to continue the movement at increasing speeds. The balloon analogy fails because it is increasing in only two dimensions.

Link To: The Big Bang

Difficulty Level: Hard

62. List and discuss at least two of the topics that are at the forefront of astronomy research.

Ans: Answers will vary but may include arguments about the definition of planets, the end of the universe, detecting dark matter, and so forth.

Link To: The Evolution of the Universe

Difficulty Level: Hard

63. How does the discovery of cosmic microwave background radiation support the big bang theory?

Ans: Suggests a change in temperature, which supports inflation theory.

Link To: The Big Bang

Difficulty Level: Hard

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64. What type of evidence would you need to support the big bang theory in a public forum with the creationists on the Kansas School Board?

Ans: Answers will vary. Faith does not require evidence; theories do.

Link To: [The Big Bang](#)

Difficulty Level: Hard

65. Summarize the cosmology principles surrounding the "galaxy problem" in current astronomy.

Ans: Answers will vary but should include information about dark matter and clumping as well as clumping in relation to background radiation.

Link To: [The Evolution of the Universe](#)

Difficulty Level: Hard

66. How is it that every point in the universe appears to be the center of the universe?

Ans: It is relative because no matter what your observation point, all other galaxies appear to be rushing away from you.

Link To: [The Redshift and Hubble's Law](#)

Difficulty Level: Hard

67. Traditionally, the fate of the universe is tied to the amount of mass, but what role might dark energy/dark mass play in this fate?

Ans: Answers will vary—among Nobel laureates, as well. As future observations tell us more about dark energy/matter, these observations will allow further theoretical models.

Link To: [The End of the Universe](#)

Difficulty Level: Hard

68. Why are not all galaxies the same shape and size? What does this suggest about their history?

Ans: Size is a factor of the early gravitational interactions. Shape is a factor of gravitational interaction with other galaxies.

Link To: [Galaxies](#)

Difficulty Level: Hard

69. Predict what you should observe 50 billion years from now if you were to look our on a steady state universe as opposed to a big bang universe.

Ans: In a steady state universe, you would observe the same number and density of galaxies as you see now, but they would be new ones from the ones we observe 'now'. In an expanding universe if you should see any galaxies at all, they would be few and dim.

Link To: [The Big Bang](#)

Difficulty Level: Hard

70. In biology, the structure of an organism suggests its function and its function suggests its history. Can this same analogy be applied to the grouping of super clusters of galaxies in the universe—what does this geometry suggest?

Ans: Answers will vary and no one really knows, but answers must account for clustering and voids.

Link To: [The Evolution of the Universe](#)

Difficulty Level: Hard