***The Cosmic Perspective, 8e* (Bennett)**
Chapter 1 A Modern View of the Universe

1.1 Multiple-Choice Questions

1) Which of the following has your "address" in the correct order?
A) you, Earth, solar system, Local Group, Local Supercluster, Milky Way
B) you, Earth, solar system, Milky Way, Local Supercluster, Local Group
C) you, Earth, solar system, Local Group, Milky Way, Local Supercluster
D) you, Earth, Local Group, Local Supercluster, solar system, Milky Way
E) you, Earth, solar system, Milky Way, Local Group, Local Supercluster
Answer: E

2) About where is our solar system located within the Milky Way Galaxy?
A) at the center of the galaxy
B) about 10 percent of the way from the center of the galaxy to the outskirts of the galactic disk
C) about half way from the center of the galaxy to the outskirts of the galactic disk
D) near the far outskirts of the galactic disk
E) in the halo of the galaxy above the galactic disk
Answer: C

3) Roughly how many stars are in the Milky Way Galaxy?
A) 1 billion
B) 100 billion
C) 10 billion
D) 100 million
E) 100 trillion
Answer: B

4) Modern telescopes are capable of seeing bright galaxies up to about
A) 1 million light-years away.
B) 10 million light-years away.
C) 1 billion light-years away.
D) 10 billion light-years away.
E) 1 trillion light-years away.
Answer: D

5) Suppose we imagine the Sun to be about the size of a grapefruit. How big an area would the orbits of the eight planets of the solar system cover?
A) the size of a typical dorm room
B) the size of a typical campus building
C) the size of a typical campus
D) the size of a small city
E) the size of a western state (e.g., Colorado)
Answer: C

6) What do we mean when we say that the universe is *expanding*?
A) Average distances are increasing between star systems within galaxies.
B) Everything in the universe is gradually growing in size.
C) All galaxies are increasingly moving away from one another.
D) The statement is not meant to be literal; rather, it means that our knowledge of the universe is growing.
E) Individual galaxies are gradually growing in size.
Answer: C

7) The age of the universe is
A) between 10 million and 16 million years.
B) between 100 million and 160 million years.
C) between 1 billion and 1.6 billion years.
D) between 10 billion and 16 billion years.
E) between 100 billion and 160 billion years.
Answer: D

8) How are galaxies important to our existence?
A) Without galaxies, there could not have been a Big Bang.
B) Without galaxies, the universe could not be expanding.
C) Galaxies prevent planets from leaving their orbits around stars; e.g., our galaxy prevents Earth from leaving its orbit of the Sun.
D) Galaxies recycle heavy elements produced in stars into future generations of stars.
E) Galaxies provide the gravity that prevents us from falling off Earth.
Answer: D

9) Earth is made mostly of metals and rocks. Where did this material come from?
A) It was produced in the Big Bang.
B) It was created by chemical reactions in interstellar space.
C) It was produced by the nuclear fusion in stars that made the heavy elements.
D) It was made by our Sun.
E) It was made by nuclear fission of uranium and other radioactive materials.
Answer: C

10) What is *nuclear fusion*?
A) an explosion caused by putting together two volatile chemicals
B) the process of splitting nuclei to produce energy
C) the process of turning matter into pure energy
D) the process of combining lightweight nuclei to make heavier nuclei
E) a process that only occurs in bombs
Answer: D

11) Why did Carl Sagan say that we are *star stuff*?
A) The composition of most stars (mostly hydrogen and helium) is about the same as the composition of our bodies.
B) Cosmic rays reaching Earth from distant astronomical sources may be one source of mutations that help evolution along.
C) Nearly every atom from which we are made once (before the solar system formed) was inside of a star.
D) Nearly every atom from which we are made was once inside our star, the Sun.
E) Sagan thought that all of us have the potential to be movie (or TV) stars like he was.
Answer: C

12) Which of the following statements does *not* use the term *light-year* in an appropriate way?
A) It's about 4 light-years from here to Alpha Centauri.
B) It will take me light-years to complete this homework assignment.
C) A light-year is about 10 trillion kilometers.
D) It will take the Voyager spacecraft about 20,000 years to travel just 1 light-year.
E) The Milky Way Galaxy is about 100,000 light-years in diameter.
Answer: B

13) One *light-hour* is the distance that light travels in an hour. How far is this, in kilometers? (Recall that the speed of light is 300,000 km/s.)
A) 300,000 km
B) 18 million km
C) 100 million km
D) 1.08 billion km
E) 9.46 trillion km
Answer: D

14) Suppose we look at a photograph of many galaxies. Assuming that all galaxies formed at about the same time, which galaxy in the picture is the youngest?
A) the one that is farthest away
B) the one that is reddest in color
C) the one that is bluest in color
D) the one that is closest to us
E) the one that appears smallest in size
Answer: A

15) What do we mean by the *observable universe*?
A) the part of the universe that we can see with the naked eye
B) the part of the universe that we can see through telescopes
C) the part of the universe that could be observed in principle, including things that may require future technologies
D) the compendium of all objects that we have observed to date
E) the entire universe, since it is inconceivable that there could be parts of the universe that we cannot observe
Answer: C

16) Suppose we imagine the Sun to be about the size of a grapefruit. Which of the following describes the size and distance of Earth on the same scale?
A) Earth is the size of a tip of a ballpoint pen about 1 meter away from the Sun.
B) Earth is the size of a golf ball about 1 meter away from the Sun.
C) Earth is the size of a tip of a ballpoint pen about 15 meters away from the Sun.
D) Earth is the size of a golf ball about 15 meters away from the Sun.
E) Earth is the size of a marble about 25 miles away from the Sun.
Answer: C

17) What is the Sun mainly made of?
A) hydrogen and oxygen
B) hydrogen and helium
C) carbon and nitrogen
D) oxygen and carbon
E) nearly equal portions of all the elements
Answer: B

18) Which of the following is smallest?
A) size of a typical planet
B) 1 light-second
C) 1 AU
D) size of a typical star
Answer: A

19) Which of the following is largest?
A) size of a typical galaxy
B) size of Pluto's orbit
C) distance to the nearest star (other than our Sun)
D) 1 light-year
Answer: A

20) On the 1-to-10-billion scale, about how far is it to the nearest stars besides the Sun?
A) 4 kilometers
B) 400 kilometers
C) 1,000 kilometers
D) 4,400 kilometers
E) 10,000 kilometers
Answer: D

21) Suppose we imagine the Sun to be about the size of a grapefruit. How far away are the nearest stars (the three stars of Alpha Centauri)?
A) the length of a football field (100 meters)
B) across town
C) across the state
D) across the United States
E) 25,000 miles
Answer: D

22) If we use 1 millimeter to represent 1 light-year, how large in diameter is the Milky Way Galaxy?
A) 100 millimeters
B) 100 meters
C) 1 kilometer
D) 100 kilometers
E) 1 million millimeters
Answer: B

23) Which of the following best describes the Milky Way Galaxy?
A) a barred spiral galaxy with a disk about 100,000 light-years in diameter and containing between 100 billion and 1 trillion stars
B) a barred spiral galaxy with a disk about 1 billion kilometers in diameter and containing between 100 million and 1 billion stars
C) a barred spiral galaxy with a disk about 100,000 light-years in diameter and containing about 100,000 stars
D) a spherically shaped collection of stars including our solar system and about a dozen other solar systems, stretching about 4 light-years in diameter
E) a spherically shaped collection of about 1 million stars that is about 100 light-years in diameter
Answer: A

24) How long would it take to count all the stars in the Milky Way Galaxy at a rate of one star per second?
A) several days
B) several weeks
C) several years
D) several thousand years
E) hundreds of thousands of years
Answer: D

25) How many galaxies are there in the observable universe?
A) roughly (within a factor of 10) the same as the number of stars in our galaxy
B) roughly a thousand times more than the number of stars in our galaxy
C) about as many as the number of stars we see in the sky with our naked eyes
D) about as many as the number of grains of sand on all the beaches on Earth
E) an infinite number
Answer: A

26) If you represented each star by a grain of sand, how much sand would it take to represent all the stars in the universe?
A) all the sand in a typical playground sandlot
B) all the sand on Miami Beach
C) all the sand on the beaches of California
D) all the sand on the beaches in the United States
E) more than all the sand on all the beaches on Earth
Answer: E

27) On the scale of the cosmic calendar, in which the history of the universe is compressed to 1 year, how long has human civilization (i.e., since ancient Egypt) existed?
A) about half the year
B) about a month
C) a few hours
D) a few seconds
E) less than a millionth of a second
Answer: D

28) On a cosmic calendar, in which the history of the universe is compressed into 1 year, when did the dinosaurs become extinct?
A) in late December
B) in late November
C) in late October
D) in late September
E) in late August
Answer: A

29) On a cosmic calendar, in which the history of the universe is compressed into 1 year, when did Kepler and Galileo first discover that we live on a planet in a solar system?
A) 1 second ago
B) 1 day ago
C) 1 week ago
D) December 25
E) December 30
Answer: A

30) On a cosmic calendar, in which the history of the universe is compressed into one year, how long is the average human life span?
A) 0.2 millisecond
B) 0.2 second
C) 2 seconds
D) 2 minutes
E) 2 hours
Answer: B

31) Approximately how fast are you moving with the rotation of Earth?
A) 13,000 km/hr
B) 1,300 km/hr
C) 130 km/hr
D) 13 km/hr
E) not moving at all
Answer: B

32) What is an *astronomical unit*?
A) the average speed of Earth around the Sun
B) the length of time it takes Earth to revolve around the Sun
C) the average distance from Earth to the Sun
D) the diameter of Earth's orbit around the Sun
E) any basic unit used in astronomy
Answer: C

33) Which of the following statements about the ecliptic plane is *not* true?
A) It is the plane of Earth's orbit around the Sun.
B) It is the plane of the Moon's orbit around Earth.
C) During a solar eclipse, the Moon lies in the ecliptic plane.
D) During a lunar eclipse, the Moon lies in the ecliptic plane.
E) The nodes of the Moon's orbit lie in the ecliptic plane.
Answer: B

34) Patterns of stars in constellations hardly change in appearance over times of even a few thousand years. Why?
A) Stars are fixed and never move.
B) Stars move, but they move very slowly—only a few kilometers in a thousand years.
C) Although most stars move through the sky, the brightest stars do not, and these are the ones that trace the patterns we see in the constellations.
D) The stars in our sky actually move rapidly relative to us—thousands of kilometers per hour—but are so far away that it takes a long time for this motion to make a noticeable change in the patterns in the sky.
E) Stars within a constellation move together as a group, which tends to hide their actual motion and prevent the pattern from changing.
Answer: D

35) How long does it take our solar system to complete one orbit around the Milky Way Galaxy?
A) 10 thousand years
B) 230 thousand years
C) 1 million years
D) 100 million years
E) 230 million years
Answer: E

36) Which of the following statements about the Milky Way Galaxy is *not* true?
A) It contains between 100 billion and 1 trillion stars.
B) Our solar system is located very close to the center of the Milky Way Galaxy.
C) Our view of distant objects is obscured by gas and dust when we look into the galactic plane.
D) The galaxy is about 100,000 light-years in diameter.
E) One rotation of the galaxy takes more than 200 million years.
Answer: B

37) Which of the following correctly lists speeds from slowest to fastest?
A) Earth's orbital speed about the Sun, typical speeds of stars in the local solar neighborhood relative to us, Earth's speed of rotation on its axis, the speed of our solar system orbiting the center of the Milky Way Galaxy, the speeds of very distant galaxies relative to us
B) Earth's speed of rotation on its axis, Earth's orbital speed about the Sun, typical speeds of stars in the local solar neighborhood relative to us, the speed of our solar system orbiting the center of the Milky Way Galaxy, the speeds of very distant galaxies relative to us
C) the speeds of very distant galaxies relative to us, typical speeds of stars in the local solar neighborhood relative to us, Earth's speed of rotation on its axis, Earth's orbital speed about the Sun, the speed of our solar system orbiting the center of the Milky Way Galaxy
D) the speed of our solar system orbiting the center of the Milky Way Galaxy, Earth's orbital speed about the Sun, Earth's speed of rotation on its axis, the speeds of very distant galaxies relative to us, typical speeds of stars in the local solar neighborhood relative to us
E) Earth's orbital speed about the Sun, Earth's speed of rotation on its axis, the speed of our solar system orbiting the center of the Milky Way Galaxy, typical speeds of stars in the local solar neighborhood relative to us, the speeds of very distant galaxies relative to us
Answer: B

38) Most of the mass in the Milky Way Galaxy is located
A) in the halo (above/below the disk).
B) within the disk.
C) in the stars in the spiral arms.
D) in the gas and dust.
E) in the central bulge of the galaxy.
Answer: A

39) The distribution of the mass of the Milky Way Galaxy is determined by
A) counting the number of stars.
B) determining the amount of gas and dust.
C) studying how stars are distributed in the Milky Way.
D) studying the rotation of the galaxy.
E) weighing various parts of the Milky Way.
Answer: D

40) From the fact that virtually every galaxy is moving away from us and more distant galaxies are moving away from us at a faster rate than closer ones, we conclude that
A) the Milky Way Galaxy is expanding.
B) we are located at the center of the universe.
C) the farthest galaxies will eventually be moving faster than the speed of light.
D) the universe is expanding.
E) the universe is shrinking.
Answer: D

41) By studying distant galaxies in the 1920s, Hubble made which of the following important discoveries that led us to conclude that the universe is expanding?
A) All galaxies contain billions of stars, and all galaxies have spiral shapes.
B) All galaxies were born at the same time, and all will die at the same time.
C) All galaxies outside the Local Group are moving away from us, and the farther away they are, the faster they're going.
D) All galaxies outside the Local Group are orbiting the Local Group.
E) All galaxies outside the Local Group are moving away from us, and all are moving away at nearly the same speed.
Answer: C

42) Imagine that we put a raisin cake into the oven, with each raisin separated from the others by 1 cm. An hour later, we take it out and the distances between raisins are 3 cm. If you lived in one of the raisins and watched the other raisins as the cake expanded, which of the following would you conclude?
A) All raisins would be moving away from you at the same speed.
B) More distant raisins would be moving away from you faster.
C) More distant raisins would be moving away from you more slowly.
D) It depends: If you lived in a raisin near the edge of the cake, you'd see other raisins moving away from you, but they'd be coming toward you if you lived in a raisin near the center of the cake.
E) The raisins would be expanding too, so everything would look identical to the original situation.
Answer: B

43) Which scientists played a major role in overturning the ancient idea of an Earth-centered universe, and about when?
A) Copernicus, Kepler, and Galileo; about 400 years ago
B) Aristotle and Copernicus; about 400 years ago
C) Newton and Einstein; about 100 years ago
D) Huygens and Newton; about 300 years ago
E) Aristotle and Plato; about 2,000 years ago
Answer: A

44) Is the actual size of the universe larger than 14 billion light years?
A) The observable universe is 14 billion light years in each direction, so the actual universe is greater than 14 billion light years across.
B) We do not have enough information to know this.
C) The universe must be exactly equal in size to its age, so it must not be larger than 14 billion light years across in size.
D) It is only 14 billion light years across to us; to an observer 10 billion light years away, it is smaller.
Answer: A

1.2 True/False Questions

1) Our solar system is located in the center of the Milky Way Galaxy.
Answer: FALSE

2) The solar system contains about 100 billion stars.
Answer: FALSE

3) A typical supercluster contains no more than about 10,000 stars.
Answer: FALSE

4) One light-year is about 10 trillion kilometers.
Answer: TRUE

5) In the grapefruit model of the solar system, it would take a few minutes to walk from the Sun to the inner edge of the Kuiper Belt (Pluto).
Answer: TRUE

6) The observable universe is the same size today as it was a few billion years ago.
Answer: FALSE

7) All galaxies beyond those local to the Milky Way appear to be receding from us.
Answer: TRUE

8) No galaxies existed before the Big Bang.
Answer: TRUE

9) *Voyager 2* should reach the nearest stars (besides the Sun) in about 500 years.
Answer: FALSE

10) Earth is always precisely 1 AU from the Sun.
Answer: FALSE

1.3 Short Answer Questions

1) The speed of light is 300,000 km/s. How far is a light-year? Be sure to show all work clearly on your calculations.
Answer: 1 light-year
= (speed of light) × (1 yr)
$$= \left(3000{,}000 \times \frac{\text{km}}{\text{s}}\right) \times \left(1\text{ yr} \times \frac{365}{1\text{ yr}} \times \frac{24}{1\text{ day}} \times \frac{60\text{ min}}{1\text{ hr}} \times \frac{60\text{ s}}{1\text{ min}}\right)$$
= 9,460,000,000,000 km

2) How big is Earth on the 1-to-10 billion scale described in Section 1.2?
Answer: Scaled radius of Earth = actual radius / 10^{10}
= 6,378 km / 10^{10}
= 6,378 × 10^{5} cm / 10^{10}
= 6.378 × 10^{8} cm / 10^{10}
= 6.378 × 10^{-2} cm
= 0.6 mm
This is about the size of the tip of a (fine tip) ballpoint pen.

3) Briefly explain what we mean by the statement "The farther away we look in distance, the further back we look in time."
Answer: It means that when we look at a distant object, we see it as it was some time in the past, rather than as it is now. This is because the light we see has taken time to travel from the object to us.

4) Starting from the Big Bang, briefly explain how our solar system came to contain the chemical elements necessary to make Earth and living organisms.
Answer: The Big Bang produced hydrogen and helium. Over time, stars have converted about 2 percent of this material into heavier elements, including all the elements of which we and Earth are made. Stars expel this material through winds and explosions, and the galaxy recycles it into new generations of stars. When a new star system forms, it therefore contains the ingredients needed to make planets and living organisms.

5) Briefly explain why an expanding universe implies a beginning (called a Big Bang).
Answer: The fact that the universe is expanding means the average distance between galaxies is growing, which implies that this average distance was smaller in the past. Extrapolating back in time, there must have been a time when the distance between galaxies (or their precursors) was zero, which must be the beginning of the universe.

6) Consider the following statement, and explain whether or not it is sensible: NASA hopes to build a new telescope that will allow us to see 100 million light-years into the past.
Answer: Not sensible: It uses light-years as a length of time.

7) Consider the following statement, and explain whether or not it is sensible: NASA hopes to build a new telescope that will allow us to see some galaxies as they appeared 8 billion years ago.
Answer: Sensible: By looking to a distance of 8 billion light-years, we can see objects as they looked 8 billion years ago.

8) Consider the following statement, and explain whether or not it is sensible: The universe is between 10 and 16 billion light-years old.
Answer: This statement does not make sense because it uses the term *light-year* as a length of time, rather than as a distance.

9) Consider the following statement, and explain whether or not it is sensible: It will take me light-years to complete this homework assignment.
Answer: This statement does not make sense because it uses the term *light-year* as a length of time, rather than as a distance.

10) Consider the following statement, and explain whether or not it is sensible: Someday we may build spaceships capable of traveling at a speed of 1 light-second per hour.
Answer: This statement is fine. A light-second is 300,000 kilometers, so it simply says that we'll someday build spaceships that can travel at a speed of 300,000 km/hr.

11) Briefly explain how the Sun generates energy.
Answer: The Sun generates energy through nuclear fusion in its core, converting hydrogen into helium. This process releases energy because a small amount of the mass of the hydrogen is converted to energy.

12) Imagine that you could drive your car in space. Assume that you can drive at a constant speed of 100 kilometers per hour. Suppose you started driving from the Sun. How long would it take, in years, to reach Earth?
Answer: $t = \frac{149.6 \text{ million km}}{100 \text{ km/hr}}$ = 1.5 million hours = 171 years

It would take about 171 years to drive from the Sun to Earth.

13) Explain why it is so difficult to see planets around other stars.
Answer: Planets are very faint compared to the stars they orbit. Moreover, they are very close to their parent star compared to the distance between stars. On the 1-to-10 billion scale, where the Sun is the size of a grapefruit and Earth is a pinhead about 15 meters way, the nearest star is several thousand kilometers away. Together, this makes it extremely difficult to distinguish the faint light of a planet from the star it orbits. (Nevertheless, massive Jupiter-like planets have been *indirectly* detected orbiting around nearby stars.)

14) Based on the idea of "spaceship Earth," write one or two paragraphs explaining why it is not the case that we are "just sitting here."
Answer: Far from just sitting still, we on Earth are moving relative to the Sun, planets, stars, and even other galaxies. The rotation of Earth causes the most noticeable changes in the sky. This motion around Earth's axis causes the Sun and stars to appear to rise and set, producing what we call a "day." The revolution of Earth about the Sun produces the monthly changes of the constellations, the seasonal weather changes due to Earth's tilt, and the parallax of some stars. The precession of Earth's axis, a very slow movement that has a period of 26,000 years, causes the movement of the North Star, and the changing position of the equinoxes and solstices.

The motion of the Sun relative to the stars in the local solar neighborhood is at an extremely fast speed, although barely noticeable. Over time, this movement causes the patterns of the stars in the sky to change. The rotation of the galaxy means that the entire solar system is also orbiting the center of the Milky Way. This also produces motions of stars and clouds of gas. The expansion of the universe, the fact that the space between most galaxies is increasing with time, means that almost all galaxies outside the Local Group are moving away from us, with the more distant ones moving away faster. All of these motions, although not felt by us on Earth, are observed by watching the sky and prove that we are not "just sitting here."

15) How fast is the Moon orbiting Earth?
Answer: From Appendix E, you can find that the distance from Earth to the Moon is 384.4 x 10^3 km and the orbital period of the Moon around Earth is 27.322 days.
The orbital circumference is therefore $2 \times \pi \times 3.844 \times 10^5$ km $\approx 2.42 \times 10^6$ km, and the orbital period in hours is $27.322 \times 24 \approx 6.56$ hours. Therefore,

$$\text{orbital speed} = \frac{\text{oribital circumference}}{\text{orbital period}}$$

$$= \frac{2.42 \times 10^6 \text{ km}}{656 \text{ hours}}$$

$$\approx 3700 \text{ km/hr}$$

16) Consider the following statement, and explain whether or not it is sensible: Earth is always precisely 1 AU from the Sun.
Answer: Not sensible: One AU is the average distance between Earth and the Sun.

17) *Process of Science*: Devise an experiment that would produce evidence (not necessarily proof) that Earth is round. You may use any technology you like, but you may not leave Earth (i.e., no satellite photos and no space travel). Be as creative as you like there are many right answers.
Answer: Some answers are: circumnavigate the globe; call a friend in Japan during the day here and find out that it's night there; watch the sails of ships sailing off into the distance; observe Polaris from the North Pole and watch its position change as you move towards the equator, etc.

18) Process of Science: Think of some ways in which you can demonstrate the following by simply looking at the sky:
a) the Sun and stars lie beyond the Earth's atmosphere
b) the stars are further away than the Moon
Answer:
a) The Sun and stars disappear behind clouds. That tells us that clouds, in our atmosphere, lie between us and the stars.
b) As the Moon moves across the sky, it blocks out ("occults") stars. This tells us that the Moon lies between us and the stars.

19) Process of Science: Think about some ways in which we might figure out how old things are that last for much longer than a human lifetime. What about for things that last longer than humans have existed?
Answer: For relatively recent events, we can look at the human historical record as written in books, painted on rocks, or just passed on orally from generation to generation. There are several such examples that pertain to astronomical phenomena such as comets and supernovae. In the case of events that happened before humans existed, we have to look at evidence in the Earth's geological record. An example is the iridium layer that suggests a massive explosion the spread ejecta around the globe. We can also use radioisotope dating where we use the known timescale for the decay of a radioactive element to measure the age of an object such as a meteorite.

20) Explain why Pluto is no longer considered a planet.
Answer: Although it orbits a star and is large enough for its own gravity to make it round, Pluto has not cleared most other objects from its orbital path.

1.4 Mastering Astronomy Reading Quiz

1) Which of the following is *not* a general difference between a planet and a star?
A) Planets are smaller than stars.
B) Planets are dimmer than stars.
C) All planets are made of rock and all stars are made of gas.
D) Planets orbit stars, while stars orbit the center of the galaxy.
Answer: C

2) Our solar system consists of
A) the Sun and all the objects that orbit it.
B) the Sun and the planets, and nothing else.
C) a few hundred billion stars, bound together by gravity.
D) the Sun and several nearby stars, as well as the planets and other objects that orbit these stars.
Answer: A

3) A typical galaxy is a
A) collection of a few hundred million to a trillion or more stars, bound together by gravity.
B) large, glowing ball of gas powered by nuclear energy.
C) nearby object orbiting a planet.
D) relatively small, icy object orbiting a star.
Answer: A

4) Which of the following best describes what we mean by the *universe*?
A) the sum total of all matter and energy everywhere
B) a vast collection of stars that number as many as the grains of sand on all the beaches on Earth
C) all the galaxies in all the superclusters
D) The universe is another name for our Milky Way Galaxy.
Answer: A

5) What do astronomers mean by the *Big Bang*?
A) the event that marked the beginning of the expansion of the universe
B) a gigantic explosion that blew all the galaxies in the universe to smithereens
C) the explosion of a massive star at the end of its life
D) the event that marked the birth of our solar system
Answer: A

6) What do we mean when we say that the universe is *expanding*?
A) Everything in the universe is gradually growing in size.
B) Within galaxies, average distances between star systems are increasing with time.
C) The statement is not meant to be literal; rather, it means that our knowledge of the universe is growing.
D) Average distances between galaxies are increasing with time.
Answer: D

7) Based on observations of the universal expansion, the age of the universe is about
A) 14,000 years.
B) 14 million years.
C) 14 billion years.
D) 14 trillion years.
Answer: C

8) A television advertisement claiming that a product is light-years ahead of its time does not make sense because
A) it doesn't specify the number of light-years.
B) it uses "light-years" to talk about time, but a light-year is a unit of distance.
C) a light-year is an astronomically large unit, so a product could not possibly be so advanced.
D) light-years can only be used to talk about light.
Answer: B

9) The term *observable universe* refers to
A) that portion of the universe that we have so far photographed through telescopes.
B) the portion of the universe that can be seen by the naked eye.
C) the portion of the universe that is not hidden from view by, for example, being below the horizon.
D) that portion of the universe that we can see *in principle*, given the current age of the universe.
Answer: D

10) On a scale in which the distance from Earth to the Sun is about 15 meters, the distance from Earth to the Moon is
A) small enough to fit within your hand.
B) about 1 meter.
C) about 5 meters.
D) about 30 meters.
Answer: A

11) On a scale where the Sun is about the size of a grapefruit and the Earth is about 15 meters away, how far away are the nearest stars besides the Sun?
A) 100 meters
B) about the distance across 50 football fields
C) about the distance across the state of Delaware
D) about the distance across the United States
Answer: D

12) The number of stars in the Milky Way Galaxy is approximately
A) a few hundred.
B) a few hundred thousand.
C) a few hundred billion.
D) a few hundred million.
Answer: C

13) An astronomical unit (AU) is
A) any very large unit, such as a light-year.
B) the *average* distance between Earth and the Sun.
C) the *current* distance between Earth and the Sun.
D) the average distance between any planet and the Sun.
Answer: B

14) What is the ecliptic plane?
A) the plane of Earth's orbit around the Sun
B) the plane of Earth's equator
C) the plane of the Sun's equator
D) the plane of the Milky Way Galaxy
Answer: A

15) How long does it take the Earth to complete one orbit around the Sun?
A) one year
B) one day
C) one month
D) one week
E) The time it takes Earth to orbit the Sun changes significantly from one orbit to the next.
Answer: A

1.5 Mastering Astronomy Concept Quiz

1) Which of the following has your "cosmic address" in the correct order?
A) You, Earth, solar system, Local Group, Local Supercluster, Milky Way Galaxy, universe
B) You, Earth, solar system, Milky Way Galaxy, Local Group, Local Supercluster, universe
C) You, Earth, Local Group, Local Supercluster, solar system, Milky Way Galaxy, universe
D) You, Earth, solar system, Local Group, Milky Way Galaxy, Local Supercluster, universe
E) You, Earth, Milky Way Galaxy, solar system, Local Group, Local Supercluster, universe
Answer: B

2) Using the ideas discussed in your textbook, in what sense are we "star stuff"?
A) The overall chemical composition of our bodies is about the same as that of stars.
B) Movie stars and other people are all made of the same stuff, so we all have the potential to be famous.
C) Nearly every atom from which we are made was once inside of a star.
D) We could not survive without light from our star, the Sun.
Answer: C

3) How are galaxies important to our existence?
A) Without galaxies, there could not have been a Big Bang.
B) Without galaxies, the universe could not be expanding.
C) Deep in their centers, galaxies created the elements from which we are made.
D) Galaxies recycle material from one generation of stars to the next, and without this recycling we could not exist.
Answer: D

4) When we look at an object that is 1,000 light-years away we see it
A) as it was 1,000 years ago.
B) as it was 1,000 light-years ago.
C) as it is right now, but it appears 1,000 times dimmer.
D) looking just the same as our ancestors would have seen it 1,000 years ago.
Answer: A

5) Suppose we look at two distant galaxies: Galaxy 1 is twice as far away as Galaxy 2. In this case,
A) Galaxy 1 must be twice as big as Galaxy 2.
B) we are seeing Galaxy 1 as it looked at an *earlier* time in the history of the universe than Galaxy 2.
C) we are seeing Galaxy 1 as it looked at a *later* time in the history of the universe than Galaxy 2.
D) Galaxy 2 must be twice as old as Galaxy 1.
Answer: B

6) Suppose we make a scale model of our solar system, with the Sun the size of a grapefruit. Which of the following best describes what the planets would look like?
A) The planets are all much smaller than the Sun. Four planets are within about 20 meters of the Sun, while the rest planets are spread much farther apart.
B) The planets are all much smaller than the Sun and are spread out evenly over a distance about the length of a large classroom.
C) The planets are all much smaller than the Sun. Four planets are located within a few centimeters of the Sun, and four planets are located at distances ranging up to about a meter.
D) The planets range in size from about the size of a marble to the size of a baseball. They are spread out over 100 meters.
Answer: A

7) If you could count stars at a rate of about one per second, how long would it take to count all the stars in the Milky Way Galaxy?
A) several days
B) several weeks
C) several years
D) several thousand years
Answer: D

8) The total number of stars in the observable universe is about
A) 100 billion.
B) the same as the number of grains of sand in a school sandbox.
C) the same as the number of grains of sand on all the beaches on Earth.
D) the same as the number of atoms that make up the Earth.
Answer: C

9) Where is our solar system located within the Milky Way Galaxy?
A) very near the center of the galaxy
B) at the far edge of the galaxy's visible disk
C) roughly halfway between the center and the edge of the visible disk of the galaxy
D) in the halo of the galaxy
Answer: C

10) If we imagine the history of the universe compressed into one year, dinosaurs became extinct
A) about 6 months ago.
B) about 3 weeks ago.
C) yesterday morning.
D) about an hour ago.
Answer: C

11) Relative to the age of the universe, how old is our solar system?
A) It is about 1% as old as the universe.
B) It is between about 5% and 10% as old as the universe.
C) It is about one-third the age of the universe.
D) It is nearly the same age as the universe.
Answer: C

12) How do the speeds at which we are moving with Earth's rotation and orbit compare to the speeds of more familiar objects?
A) Earth's rotation carries most people around the axis faster than a commercial jet travels, and Earth's orbit carries us around the Sun faster than the Space Shuttle orbits Earth.
B) Earth's rotation carries most people around the axis at about the speed of a commercial jet, and Earth's orbit carries us around the Sun at a higher speed.
C) Earth's rotation carries most people around the axis at about the speed of a car on the freeway, and Earth's orbit carries us around the Sun at about the speed of a commercial jet.
D) Earth's rotation carries most people around the axis at about the speed at which the Space Shuttle orbits Earth, and Earth's orbit carries us around the Sun at nearly the speed of light.
Answer: A

13) Why do the patterns of the stars in our sky look the same from year to year?
A) because the stars in the constellations are so far away
B) because the stars in the constellations are not moving
C) because the stars in the constellations all move at the same speeds and in the same directions, so they don't change their relative positions
D) because the stars in the constellations move so slowly—typically about the speed of a snail—that their motions are not noticeable
Answer: A

14) Astronomers infer that the universe is expanding because distant galaxies all appear to
A) be growing in size.
B) be moving away from us, with more distant ones moving faster.
C) be made mostly of dark matter.
D) rotate rapidly.
Answer: B

15) Which statement about motion in the universe is *not* true?
A) The mysterious *dark matter* is the fastest-moving material in the universe.
B) Some stars in the Milky Way Galaxy are moving toward us and others are moving away from us.
C) Except for a few nearby galaxies, all other galaxies are moving away from us.
D) Your speed of rotation around Earth's axis is faster if you live near the equator than if you live near the North Pole.
Answer: A

16) When did humans learn that the Earth is not the center of the universe?
A) within the past 500 years
B) about 2,500 years ago
C) about 1,000 years ago
D) We haven't; there is still considerable scientific debate about whether Earth is the center of the universe.
Answer: A