***The Essential Cosmic Perspective, 8e* (Bennett et al.)**

**Chapter 1 A Modern View of the Universe**

1.1 Multiple Choice Questions

1) The farthest galaxies that modern telescopes are capable of seeing are up to

A) 10 million light-years away.

B) 1 billion light-years away.

C) 5 billion light-years away.

D) 10 billion light-years away.

E) 1 trillion light-years away.

Answer: D

2) 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 small room

B) the size of a building

C) the size of a typical college campus

D) the size of a small city

E) the size of a western state (e.g.,Colorado)

Answer: C

3) Earth is made mostly of metals and rocks. Where did the elements (carbon, silicon, iron, etc.) that make up these materials form?

A) They were produced by the Big Bang.

B) They are a product of chemical reactions in interstellar gas clouds.

C) They were produced by nuclear fusion in stars.

D) They were produced by nuclear fusion in our Sun.

E) They were produced by nuclear fission of uranium and other radioactive materials in space.

Answer: C

4) 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 combination of exotic nuclei of very different types of heavy elements

D) the process of combining lighter weight nuclei to make heavier nuclei

E) a process that only occurs in nuclear bombs

Answer: D

5) On the cosmic calendar, where every month is about 1.2 billion years long, and where the Big Bang happened on January 1, when did the Sun and Earth form?

A) January

B) December

C) September

D) February

Answer: C

6) Light takes approximately one second to travel from Earth to the Moon. This means that the Moon is approximately

A) 1 astronomical unit from Earth.

B) 1 light-year from Earth.

C) 3,000 kilometers from Earth.

D) 300,000 kilometers from Earth.

E) near the top of Earth's atmosphere.

Answer: D

7) Recall the raisin cake model of the universe. Our universe is expanding between the galaxies. You measure the recession velocity of Galaxy A to be 2,000 km/sec and the recession velocity of Galaxy B to be 6,000 km/sec. What can you say about the distances to these galaxies?

A) The relative distances cannot be determined from the information in this problem.

B) Galaxy B is 9 times closer than Galaxy A.

C) Galaxy B is 9 times farther than Galaxy A.

D) Galaxy B is 6 times farther than Galaxy A.

Answer: D

8) Suppose we look at a photograph of many galaxies. Assuming that all of these galaxies formed at the same time after the Big Bang, which galaxies, as seen in the photo, would appear to be the youngest?

A) those galaxies that are the furthest away

B) those galaxies that are closest to us

C) those galaxies whose actual size is small

D) those galaxies that appear to be the bluest

E) All of the galaxies would appear to be at the same age.

Answer: A

9) Sunlight takes 8.4 minutes to get from the Sun to Earth. When NASA's *New Horizons* Spacecraft passed Pluto in 2016, it was 33 AU from Earth. How long did it take for its transmitted images of Pluto to arrive at Earth?

A) One Plutonian year

B) 277.3 hours

C) 4.6 hours

D) They arrived almost instantaneously. The transmitted signals were radio signals and therefore traveled at the speed of light.

Answer: C

10) How are galaxies able to recycle the material of stars?

A) As the stars burn, they grow smaller. The gravity of the galaxy joins them together.

B) As a galaxy rotates, the stars cycle around the galaxy center again and again, returning to where they started.

C) New stars are continuously being formed in galaxies out of the gas that has been ejected during the evolution of a previous generation of stars.

D) New galaxies are continuously being formed from gas that remains after the explosion of previous galaxies.

E) In the formation of a star, no matter is wasted. All excess material ends up recycled into orbiting planets.

Answer: C

11) 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

12) What is the evidence for the existence of the mysterious "Dark Matter"?

A) We are unable to see the stars that are located at large distances from us across the Milky Way Galaxy suggesting unknown "Dark Matter" is absorbing their light.

B) The outer parts of galaxies rotate about their centers at unexpected velocities. These velocities indicate that there are massive halos around each galaxy made of matter invisible to astronomers.

C) The expansion of the universe is observed to be accelerating, implying a repulsive force due to the unknown presence of "Dark Matter".

D) Anti-matter (expected to be formed in the Big Bang) has never been seen. Hence, it is referred to as the "Dark Matter".

Answer: A

13) The universe is defined as

A) all the stars and galaxies that we can see with telescopes.

B) all the objects we can see and the space between them.

C) all material, space, and energy that exist: everything.

D) the entire Milky Way Galaxy.

Answer: C

14) When both are viewed from a distance away from Earth, would a person standing on the South Pole appear to be oriented upside down compared with a person standing on the North Pole?

A) No, they would both be standing in the same orientation because "up" is always in the same direction on Earth.

B) No, that would imply the South Pole person would fall off the globe.

C) Yes, but they each would believe they were standing upright.

D) Yes, but they would each have the North Star, Polaris, above their head.

Answer: C

15) The fact that the expansion of the universe is seen to be accelerating suggests

A) the Big Bang explosion caused the constant expansion of space.

B) the gravity of distant galaxies is pulling the universe apart ever faster.

C) the universe is destined to contract in the distant future.

D) an unknown repulsive force, called "Dark Energy", is present in the universe.

E) "Dark Matter" is present between galaxies.

Answer: D

16) Where was the Hydrogen in the universe formed?

A) in the Big Bang

B) in chemical reactions in interstellar space

C) from the dissociation of water (H2O)

D) in the cores of stars

Answer: A

17) Which of the following best describes the Milky Way Galaxy?

A) a disk-shaped galaxy about 50,000 light**-**years in radius and containing between 100 billion and 1 trillion stars

B) a disk-shaped galaxy about 50,000 light-years in diameter and containing between 100 million and 1 billion stars

C) a disk-shaped galaxy about 100,000 light**-**years in diameter and containing between 100 million and 1 billion 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

18) 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) infinity

Answer: A

19) On the scale of the cosmic calendar, in which the history of the universe is compressed to one 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) about 10 seconds

E) less than a thousandth of a second

Answer: D

20) On a cosmic calendar, in which the history of the universe is compressed into one year, when did the dinosaurs become extinct, given that they became extinct 64 million years ago?

A) in the last 2 days of the year

B) in the last 3 weeks of the year

C) in the last 3 months of the year

D) in late September

E) in late August

Answer: A

21) On a cosmic calendar, in which the history of the universe is compressed into one 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

22) Approximately how fast is a person located at the Earth's equator traveling due to the rotation of the Earth?

A) 17,000 km/hr

B) 1,700 km/hr

C) 170 km/hr

D) 17 km/hr

E) not moving at all

Answer: B

23) 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

24) How much of the hydrogen and helium of the universe had been converted into heavier elements when the universe was 1/3 its current age (when Earth formed)?

A) 20%

B) 10%

C) 5%

D) 2%

Answer: D

25) Which of the following correctly lists speeds from slowest to fastest?

A) Earth's speed of revolution 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, typical speeds of stars in the local solar neighborhood relative to us, Earth's speed of revolution about the Sun, 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 speed of revolution 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 speed of revolution 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 speed of revolution 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

26) 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 disk and bulge.

D) in the gas and dust.

E) in the combination of the stars and the gas in the disk and the central bulge of the galaxy.

Answer: A

27) 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

28) The reason galaxies that are distant from our galaxy move away from our galaxy more rapidly than those that are near is

A) the more distant galaxies formed first with higher speeds.

B) the more distant galaxies are smaller and less massive, so they can move faster.

C) the nearby galaxies are slowed by our galaxy's gravitational pull.

D) more space expands between us and the distant galaxies.

Answer: D

29) By studying distant galaxies in the 1920s, Hubble made the following important discovery 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

30) 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 left side 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 right side of the cake.

Answer: B

31) How many seconds are in one year? (Calculate this, do not look it up.)

A) about 380 million (380,000,000, or 3.8 × 108)

B) about 30 million (30,000,000, or 3 × 107)

C) about 86 thousand (86,000, or 8.6 × 105)

D) about 3,600 (3.6 × 103)

Answer: B

32) Astronomer Alan says the universe is expanding at one rate and Astronomer Wendy says it is expanding at a faster rate. All other things being equal, which astronomer would say that the universe is OLDER?

A) Wendy

B) Alan

C) Neither

Answer: B

33) When did the Sun form?

A) The Sun formed before our galaxy formed, and gravity between the stars formed our galaxy.

B) The Sun and our galaxy formed together.

C) The Sun formed long after our galaxy formed.

D) Astronomers think that the Sun and the galaxy formed at nearly the same time by the same process, but are unsure about this.

Answer: C

34) The total energy of the universe is now thought to be dominated by

A) the gas between the stars.

B) Dark Energy.

C) the stars within galaxy clusters and superclusters.

D) Dark Matter.

Answer: B

35) One light-hour is the distance light travels in one hour. The speed of light is about 300,000 km/s (3 × 105 km/s). If Jupiter is 0.72 light hours from the Sun, how far is this?

A) 216 thousand km (2.15 × 105 km)

B) 13 million km (1.3 × 107 km)

C) 778 million km (7.78 × 108 km)

D) 1.5 billion km (1.5 × 109 km)

Answer: C

36) The planet Mars is, on average, about 228 million km from the Sun. How long does it take light from the Sun to reach Mars? (Recall that the speed of light is about 300,000 km/s.)

A) about 8.4 minutes

B) about 12.7 minutes

C) about 1.52 light seconds

D) about 1.52 hours

Answer: B

37) One light-year is the distance light travels in one year. The speed of light is about 300,000 km/s (3 × 105 km/s). How far is 1 light-year?

A) 3 × 105 km

B) 1.8 × 107 km

C) 1.08 × 109 km

D) 9.46 × 1012 km

Answer: D

38) Where did the elements hydrogen and most helium form?

A) Stars

B) Planets

C) Comets

D) Big Bang

Answer: D

39) If the entire galaxy (with a diameter of 100,000 light-years) were represented by a circle with a diameter of 4,400 km (similar to the width of the continental United States), then how far apart would be the Sun and its nearest stellar neighbor, Proxima Centauri (which is 4.2 light-years away)?

A) about 0.2 meters (about the length of an adult's forearm)

B) about 2 meters (about 2 long footsteps)

C) about 20 meters (about the size of a large classroom)

D) about 200 meters (about 2 football fields)

Answer: D

40) The Earth has a radius of about 6,000 km. How long would it take for an object traveling at the speed of light to circle the earth? (Recall that the speed of light is 300,000 km/s.)

A) 1/300,000 of a second (0.0000033 s)

B) 1/6000 of a second (0.000017s)

C) 1/8 of a second (0.0125 s)

D) 1/2 of a second (0.5 s)

Answer: C

41) Our solar system is located about 27,000 light-years from the galactic center. How far does our solar system travel in one orbit?

A) 54,000 light-years

B) 85,000 light-years

C) 100,000 light-years

D) 170,000 light-years

Answer: D

42) A person located on the equator is orbiting the center of the Earth to the East at 1670 km/s. Relative to the center of the Earth, a person on the North Pole is

A) moving at the same velocity to the East, since they are both on the same planet in space.

B) moving toward the South at the same velocity.

C) not moving at all.

D) stationary, except spinning in-place once per day.

Answer: D

43) Light travels 300,000 km/sec. About how far is a light-year?

A) 10 million meters

B) 10 billion km

C) 300,000 km

D) 10 trillion km

Answer: D

1.2 True/False Questions

1) Earth rotates on it axis each day, the Moon orbits Earth in a little less than one month, and Earth orbits the Sun each year.

Answer: TRUE

2) While, night after night, the stars seem not to move relative to each other, they are actually moving in random directions with relative to each other with typical velocities of about 70,000 km/hr.

Answer: TRUE

3) A typical supercluster contains no more than about 10 billion stars.

Answer: FALSE

4) One light-year is about 9.5 trillion kilometers.

Answer: TRUE

5) In a model of the solar system, where the Sun is the size of a grapefruit, it would take a few minutes to walk from the Sun to Pluto.

Answer: TRUE

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

Answer: FALSE

7) The Milky Way is moving further away from most other galaxies in the universe.

Answer: TRUE

8) NASA's *New Horizons* Spacecraft passed Pluto going 60,000 km/hr. Therefore, it was 1 million km past Pluto in less than a day.

Answer: TRUE

9) NASA's *New Horizons* Spacecraft, which passed Pluto in 2016*,* should reach the nearest star system (beyond our solar system) in about 500 years.

Answer: FALSE

10) As Earth orbits the Sun, its axis is tilted from the vertical by 23-1/2 degrees, with the North Pole always tipped toward the Sun.

Answer: FALSE

11) The solar system is a member of a galaxy containing approximately 100 billion stars.

Answer: TRUE

12) In the expanding universe, the Andromeda Galaxy is moving away from the Milky Way Galaxy.

Answer: FALSE

13) Compared to the length of its diameter, the Milky Way is more than tens of thousands of these lengths away from all other galaxies.

Answer: FALSE

1.3 Process of Science Questions

1) *Light Travel Time*: Because of the finite speed of light, we see more distant objects as they were in the past. For example, we see the star Alpha Centauri as it was 4.4 years ago, and the Andromeda Galaxy as it was 2.5 million years ago. Astronomers are often asked how we know that these objects still exist when we look at them in the night sky. How would you try to answer this question?

Answer: Will vary.

2) *The Observable Universe*: How does the age of the universe (estimated at 14 billion years) relate to the concept of the "observable universe?" Suppose you feel, as do many astronomers, that the universe is much larger than the observable universe. Do you think there is any way to obtain direct evidence for this larger universe? If the universe is much larger than the Observable Universe, moreover, if the universe is infinite, as many astronomers believe, how can we be justified in drawing conclusions about the general nature of the universe by examining only our local infinitesimal part of it?

Answer: Will vary.

3) *Light travel time:* Our solar system is a little more than halfway from the center of our galactic disk, about 27,000 light-years. When we view stars and gas located at the far edge of the galaxy disk, located on the opposite side of the galactic center, we are looking out across 77,000 light-years of space. While our Sun orbits the center once in about 200 million years, we know that this distant material takes about 400 million years to go around once. Since we are looking at light from a part of our galaxy that has moved on since the light left it, are we getting a distorted view of our galaxy's disk?

Answer: The opposing material has moved through only a small part of its orbit:

(0.077 106 yr /400 106 yr) ∗ 360 degrees = 0.07 degrees, so there is little distortion.

4) *Stellar and galactic crowding*: The comparison of objects' sizes to the distance between them gives a sense of their relative density, i.e., how "crowded" they are. A typical human is about 1 meter across the shoulders. Compare the relative density of people in the case where they are standing on average 1 meter apart compared to a situation where they are on average 10 meters apart (hint: describe the separation in units of person-size). Now, compare the "crowding" of stars to that of galaxies. A typical star has a diameter of about 1 million km, while the average space between stars is about 5 light-years. A typical spiral galaxy in a cluster (such as the Milky Way) is 100,000 light-years across, and has another spiral galaxy within about 10 million light-years.

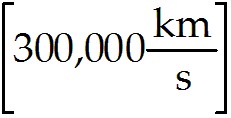
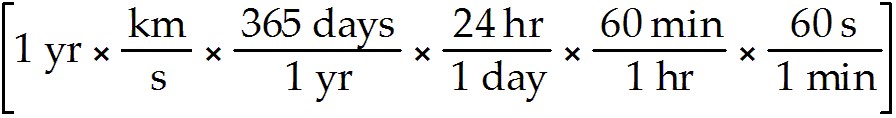
Answer: Students should reference the ratio of distance to size (or vice versa), to show that compared to their size, stars are much, much further apart than galaxies.

1.4 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 calculation.

Answer: 1 light-year

= (speed of light) × (1 yr)

=  × 

= 9,460,000,000,000 km

2) 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.

3) 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 only hydrogen and helium and traces of Lithium. Over time, through fusion, generations of stars have converted about 2 percent of the H and He into heavier elements. These heavy elements were dispersed into the galactic disk by stellar explosions and winds. The heavy elements were components of the gas cloud that gravitationally collapsed to form our Sun and planets. Enough heavy elements were present to form the inner rocky planets, such as Earth. Within a billion years, carbon compounds on Earth's surface provided the chemical basis for all life we know.

4) Briefly explain why an expanding universe implies a beginning (called the Big Bang).

Answer: In an expanding universe, galaxies recede from one another over time. If we imagine running a clock backwards from the present to the past, galaxies are then seen to continuously *approach* each other, and at some time in the past, *the beginning*, must all be together. While a constant expansion is the simplest case, there may have been (or even now be) periods of outward accelerations in the expansion. Yet, the fact remains that a continuous expansion requires a beginning; a point in time when the expansion began.

5) Standing on Earth, we are experiencing many different motions at once: the rotating Earth; the Sun-orbiting Earth; the solar system's orbit of the galactic orbit, etc., all with enormous velocities. Why do we not feel these motions, like one does, say, on a roller coaster?

Answer: The circles of these orbits are each so large that over small periods of time, say an hour, our motion is always, essentially, in an extremely straight line, not an arc. This is why we feel no force, even while all of these motions are combined so as to propel us through space. Were we attached to a smaller object spinning very rapidly or orbiting very rapidly, we would then feel forces due to our acceleration.

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 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.

7) As we watch the sky in daytime and nighttime, we see the Sun, Moon, and stars on the horizon rise in the East and track through the sky to set in the West. What causes this illusion of motion?

Answer: Earth is spinning on its axis once a day beneath them.

8) Name the rotation and orbit motions associated with time intervals of days, months, and years.

Answer: Earth rotates in a day, the Moon orbits Earth in about a month, and Earth orbits the Sun in a year.

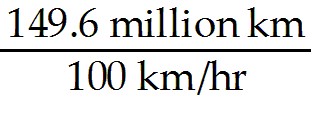
9) Consider the following statement, and explain whether or not it is sensible: Someday we may build spaceships capable of traveling at a speed of 1 light-second per hour.

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.

10) 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.

11) 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* =  = 1.5 million hours = 171 years

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

12) 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. A distant star and exoplanet might display the same geometry of the Sun and Earth (a grapefruit and pinhead) at this distance. Or, the situation could be even more difficult: the nearest exoplanet, b Proxima Centauri, lies 20 times closer to its star than the Earth is to the Sun. Imagine a region of the sky blocked by a sand grain held at arm's length. This nearest exoplanet planet and star would be separated by 1/10,000th of the width of that region. (Nevertheless, a great number of planets in sizes ranging from Earth-size to larger-than-Jupiter have been *indirectly* detected orbiting nearby stars, and a few massive Jupiter-like planets have been *directly* imaged, as well.)

13) Given the idea that we are on "spaceship Earth," list our motions through space that show why it is not the case that we are "just sitting here."

Answer: While we are "just sitting here" we are: spinning with the Earth at about 1000 km/hr (at 40 deg. latitude); orbiting the Sun at 100,000 km/hr, orbiting the galactic center at 800,000 km/hr and participating in the universe's general expansion.

14) What is the difference between the distance and the "look back time" for a distant receding galaxy?

Answer: "Look back time" is the light travel time since the light left the galaxy while the true distance would include the additional distance that galaxy has receded in the interval between when the light left the galaxy and when we see it. So, a galaxy viewed to be 100 million light-years away will be significantly further away by the time its light has reached us.

1.5 Mastering Astronomy Reading Quiz

1) From your location on Earth right now, your trajectory through space is the combination of many different motions. Which motion adds the most velocity to total?

A) the rotation of Earth on its axis

B) the orbit of Earth around the Sun

C) the solar system's motion relative to the local stars

D) the orbit of the solar system around the center of the galaxy

Answer: D

2) As the Sun and stars in the Sun's local neighborhood orbit the center of the galaxy, they

A) often collide with each other due to the gravitational force that pulls all stars together.

B) gradually fall inward to the inner galaxy, where they accumulate in the massive central bulge.

C) usually maintain an even spacing with each other, much like the planets of the solar system.

D) each also have their own independent motions (which we cannot easily see in the night sky) as fast as 70,000 km/hour.

Answer: D

3) A galaxy is \_\_\_\_\_\_\_\_.

A) a collection of a few hundred million to a trillion or more stars, bound together by gravity

B) a large, glowing ball of gas powered by nuclear energy

C) a name for the great variety of stars.

D) another name for the universe

E) a system consisting of one or a few stars orbited by planets, moons, and smaller objects

Answer: A

4) The elements crucial for making life on Earth: Carbon, Nitrogen, Oxygen

A) were made in fusion reactions in the core of the Sun.

B) were processed through earlier generations of stars and drifted across space.

C) were generated in hydrogen and helium interactions in the Big Bang.

D) were made from hydrogen and helium interactions in galactic gas clouds.

Answer: B

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 and the galaxies and galaxy clusters are, in general, receding from each other.

C) The statement is not meant to be literal; rather, it means that our knowledge of the universe is growing.

D) The average distance between galaxies is 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) According to astronomers, how old is Earth?

A) 4.5 billion years

B) 4.5 trillion years

C) 1.5 million years old

D) 14 billion years old

Answer: A

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) We observe that most galaxies are moving away from us. If we could (somehow) communicate with an observer in a distant galaxy, what would it tell us?

A) Most galaxies are moving away from me, except for yours.

B) Most galaxies are moving away from me, including yours.

C) Most galaxies are moving away from you, and about half are moving towards me.

Answer: B

11) On the *Cosmic Calendar*, in which the entire history of the universe is represented in a single year starting on January 1, and ending now on December 31, the lives of your grandparents, your parents, and yourself have all taken place on the day 31 December

A) in less than a half second before midnight.

B) in less than 10 seconds before midnight.

C) in less than a half minute before midnight.

D) in less than 10 minutes before midnight.

Answer: A

12) The number of stars in the Milky Way Galaxy is approximately \_\_\_\_\_\_\_\_.

A) a few million

B) a few hundred million

C) a few billion

D) a few hundred billion

Answer: D

13) The *Dark Matter Halo* of our galaxy is

A) the extension or the central bulge into space where dust makes the stellar material too dark to see.

B) a massive non-luminous cloud of material that surrounds the galaxy, providing the dominant source of gravity in our galaxy.

C) a halo component curiously absent in most others galaxies which astronomers have examined.

D) a disproven super-gravity concept once thought to be possible, but contradicted by evidence.

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

1.6 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

B) you, Earth, solar system, Milky Way Galaxy, Local Group, Local Supercluster

C) you, Earth, solar system, Local Group, Milky Way Galaxy, Local Supercluster

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) Nearly every atom from which we are made was once inside of a star.

C) We could not survive without light from our star, the Sun.

Answer: B

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 facilitate recycling material from one generation of stars to the next, and, without this recycling, we would not exist.

Answer: D

4) The distance of Mars from the Sun is about 1.5 AU. How far is this in kilometers?

A) 1.5 × 150,000,000 km

B) 150,000,000,000 / 1.5 km

C) 150,000,000 / 1.5 km

D) 1.5 × 150,000,000,000 km

Answer: A

5) Suppose we look at two distant galaxies: Galaxy 1 is twice as far away as Galaxy 2. In that 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) The Moon orbits the Sun

A) once a month.

B) once a year.

C) once a day.

Answer: B

7) The mysterious *Dark Energy*

A) was suggested by the unexpected rotation speeds of galaxies.

B) is believed to be the dominant form of energy in the universe.

C) is attributed to the gravitational force of black holes.

D) is slowing the expansion of the universe.

Answer: B

8) Why don't star systems, galaxies and galaxy clusters themselves expand as the universe around them expands?

A) Actually, they do.

B) Expansion pertains to the space between objects, and not the objects themselves.

C) Their inter-gravitational attraction is strong enough to keep them bound together against the expansion of space.

D) They were formed before the period of expansion began and are thus unaffected.

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 ending today, 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 about the speed of a military jet.

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) What made most of the oxygen nuclei in the solar system?

A) stars

B) high energy collisions of dust and cosmic rays

C) the Big Bang

D) our Sun

Answer: A

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