21st Century Astronomy

FIFTH EDITION

TEST BANK

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BLOOM'S TAXONOMY

This Test Bank provides 2,400 multiple choice and short answer questions. Each chapter consists of six question levels classified according to Bloom's Taxonomy:

Remembering
Understanding
Applying
Analyzing
Evaluating
Creating

Questions are further classified by section and difficulty, making it easy to construct tests and quizzes that are meaningful and diagnostic.

Test Bank files are available in Word, PDF, and ExamView® Assessment Suite formats.

Chapter 1: Thinking Like an Astronomer

LEARNING OBJECTIVES

1.1 Earth Occupies a Small Place in the Universe

Define the bold-faced vocabulary terms within the chapter.
Multiple Choice: 1, 9, 14, 21, 29, 31, 36, 37, 40, 42, 43, 44
Short Answer: 11, 17, 18

List our cosmic address.
Multiple Choice: 22
Short Answer: 5

Differentiate the various components of our cosmic address.
Multiple Choice: 2, 6, 23
Short Answer: 1, 3

Relate the different sizes of, or the different distances between, the components of our cosmic address.
Multiple Choice: 10, 11, 15, 24, 25
Short Answer: 16

Relate astronomical distances with light-travel time.
Multiple Choice: 4, 7, 16, 17, 18, 19, 20, 26, 27, 28
Short Answer: 2, 4, 6, 10

Illustrate the size or history of the universe with scaled models.
Multiple Choice: 3, 5, 8, 12, 13
Short Answer: 7, 8, 9

1.2 Science Is a Way of Viewing the Universe

Compare the everyday and scientific meanings of *theory*.
Multiple Choice: 33, 35, 39
Short Answer: 23

Compare an *idea* with a *hypothesis.*
Multiple Choice: 32, 34
Short Answer: 12

Describe the steps of the scientific method.
Multiple Choice: 38, 41
Short Answer: 14, 20

Assess whether a given idea or explanation is scientific.
Multiple Choice: 45, 46
Short Answer: 13

Establish why all scientific knowledge is provisional.
Multiple Choice: 30
Short Answer: 15, 19, 21, 22

1.3 Astronomers Use Mathematics to Find Patterns

Identify patterns in nature.
Multiple Choice: 47, 48, 51
Short Answer: 24, 25, 26

Summarize the evidence for the statement "We are actually made of recycled stardust."
Multiple Choice: 50, 52, 54
Short Answer: 27, 29, 30

Identify fields of science that relate to the study of origins.
Multiple Choice: 53
Short Answer: 28

Working It Out 1.1

Write numbers in both scientific and standard notation.
Multiple Choice: 49, 55, 57, 58, 68

Describe characteristics of real-world objects in terms of ratios.
Multiple Choice: 56, 59, 60

Determine the mathematical behavior of proportional systems.
Multiple Choice: 61, 62, 63, 64

Working It Out 1.2

Identify the *x* and *y* axes on a graph.
Define *slope* on a graph.
Read data from linear and logarithmic graphs.
Multiple Choice: 65, 66, 69, 70

Distinguish between linear and exponential curves on a graph.
Multiple Choice: 67

MULTIPLE CHOICE

1. The word *astronomy* means
   a. "patterns among the stars."
   b. "to study the stars."
   c. "discovering the universe."
   d. "the movement of the stars."
   e. "personality traits set by the stars."

   ANS: A   DIF: Easy   REF: Section 1.1
   MSC: Remembering
   OBJ: Define the bold-faced vocabulary terms within the chapter.

2. The number of planets in our Solar System is
   a. six.
   b. eight.
   c. nine.
   d. twelve.

   ANS: B   DIF: Easy   REF: Section 1.1
   MSC: Remembering
   OBJ: Differentiate the various components of our cosmic address.

3. According to the figure below, Earth is located approximately
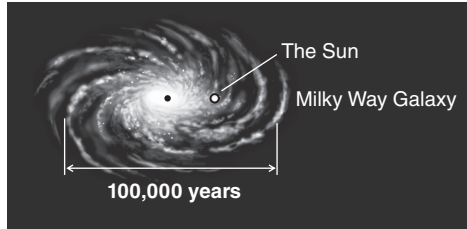
   a. at the center of the Milky Way.
   b. near the center of the Milky Way.
   c. about halfway out from the center of the Milky Way.
   d. at the farthest outskirts of the Milky Way.
   e. outside the Milky Way, which is why we can see it as a band across the night sky.

   ANS: C   DIF: Easy   REF: Section 1.1
   MSC: Understanding
   OBJ: Illustrate the size or history of the universe with scaled models.

4. The average distance between Earth and the Sun is 1.5×10^{11} m, and light from the Sun takes approximately _____ to reach Earth.
   a. 8 seconds
   b. 8 minutes
   c. 8 hours
   d. 8 days
   e. 8 years

   ANS: B   DIF: Easy   REF: Section 1.1
   MSC: Applying
   OBJ: Relate astronomical distances with light-travel time.

5. Our universe is approximately 13.7 _____ years old.
   a. thousand
   b. million
   c. billion
   d. trillion

   ANS: C   DIF: Easy   REF: Section 1.1
   MSC: Remembering
   OBJ: Illustrate the size or history of the universe with scaled models.

6. Milky Way is the name of
   a. our solar system.
   b. the galaxy in which we live.
   c. the local group of galaxies we are in.
   d. the supercluster of galaxies we are in.

   ANS: B   DIF: Easy   REF: Section 1.1
   MSC: Understanding
   OBJ: Differentiate the various components of our cosmic address.

7. One of the nearest stars is Alpha Centauri, whose distance is 4.4 light-years. The time it takes light to travel from Alpha Centauri to us is
   a. 1.25 seconds.
   b. 8.3 minutes.
   c. 4.4 years.
   d. 600 years.

   ANS: C   DIF: Easy   REF: Section 1.1
   MSC: Applying
   OBJ: Relate astronomical distances with light-travel time.

8. The time it takes light to cross Neptune's orbit is closest to which of the following?
   a. a second
   b. a quick meal
   c. a night's sleep
   d. the time between presidential elections

   ANS: C   DIF: Easy   REF: Section 1.1
   MSC: Remembering
   OBJ: Illustrate the size or history of the universe with scaled models.

9. A light-hour is a measure of
   a. time.
   b. distance.
   c. speed.
   d. acceleration.

   ANS: B   DIF: Easy   REF: Section 1.1
   MSC: Remembering
   OBJ: Define the bold-faced vocabulary terms within the chapter.

10. If one thinks about the distance between Earth and the Moon, 384,400 km, approximately how much of that distance would Saturn and its rings take up?
    a. much more than this distance
    b. less than half this distance
    c. more than half this distance
    d. exactly equal to this distance

    ANS: B   DIF: Medium   REF: Section 1.1
    MSC: Remembering
    OBJ: Relate the different sizes of, or the different distances between, the components of our cosmic address.

11. The diameter of the Moon is
    a. larger than the distance across the continental United States.
    b. roughly equal to the longest distance across Texas.
    c. more than half the distance across the continental United States.
    d. less than half the distance across the continental United States.

    ANS: C   DIF: Medium   REF: Section 1.1
    MSC: Remembering
    OBJ: Relate the different sizes of, or the different distances between, the components of our cosmic address.

12. The early universe was composed mainly of which two elements?
    a. hydrogen and helium
    b. carbon and oxygen
    c. hydrogen and oxygen
    d. carbon and iron
    e. nitrogen and oxygen

    ANS: A   DIF: Easy   REF: Section 1.1
    MSC: Remembering
    OBJ: Illustrate the size or history of the universe with scaled models.

13. What is the approximate number of stars in the Milky Way?
    a. 10 million
    b. 300 million
    c. 10 billion
    d. 300 billion
    e. 1 trillion

    ANS: D   DIF: Medium   REF: Section 1.1
    MSC: Remembering
    OBJ: Illustrate the size or history of the universe with scaled models.

14. The Local Group is the environment around
    a. the Earth-Moon system.
    b. the Sun that contains about a dozen stars.
    c. the Sun that contains over a million stars.
    d. the Milky Way that contains a few dozen galaxies.
    e. the Milky Way that contains a few thousand galaxies.

    ANS: D   DIF: Medium   REF: Section 1.1
    MSC: Remembering
    OBJ: Define the bold-faced vocabulary terms within the chapter.

15. The majority of the mass in our universe is made up of
    a. planets.
    b. stars.
    c. galaxies.
    d. dust.
    e. dark matter.

    ANS: E   DIF: Medium   REF: Section 1.1
    MSC: Remembering
    OBJ: Relate the different sizes of, or the different distances between, the components of our cosmic address.

16. The speed of light is approximately
    a. 3,000 km/s.
    b. 30,000 km/s.
    c. 300,000 km/s.
    d. 3 million km/s.
    e. 3 billion km/s.

    ANS: C   DIF: Easy   REF: Section 1.1
    MSC: Remembering
    OBJ: Relate astronomical distances with light-travel
    time.

17. If an event were to take place on the Sun, how long
    would it take for the light it generates to reach us?
    a. 8 minutes
    b. 11 hours
    c. 1 second
    d. 1 day
    e. It would reach us instantaneously.

    ANS: A   DIF: Easy   REF: Section 1.1
    MSC: Applying
    OBJ: Relate astronomical distances with light-travel
    time.

18. One of the nearest stars is Alpha Centauri, whose
    distance is 4.2×10^{16} m. How long does it take light to
    travel from Alpha Centauri to us?
    a. 1.25 seconds
    b. 8.3 minutes
    c. 4.4 years
    d. 560 years
    e. 6,200 years

    ANS: C   DIF: Medium   REF: Section 1.1
    MSC: Applying
    OBJ: Relate astronomical distances with light-travel
    time.

19. The distance to the nearest large spiral galaxy, the
    Andromeda Galaxy, is 2.4×10^{22} m. How long does it
    take light to travel from Andromeda to us?
    a. 4.4 years
    b. 360 years
    c. 1.2 thousand years
    d. 2.5 million years
    e. 4.5 billion years

    ANS: D   DIF: Medium   REF: Section 1.1
    MSC: Applying
    OBJ: Relate astronomical distances with light-travel
    time.

20. The distance to the center of the Laniakea cluster of
    galaxies is 5×10^{23} m. How long does it take light to
    travel from these galaxies to us?
    a. 7,000 years
    b. 54,000 years
    c. 120,000 years
    d. 12 million years
    e. 54 million years

    ANS: E   DIF: Medium   REF: Section 1.1
    MSC: Applying
    OBJ: Relate astronomical distances with light-travel
    time.

21. A light-year is a unit commonly used in astronomy as a
    measure of
    a. time.
    b. speed.
    c. mass.
    d. distance.
    e. acceleration.

    ANS: D   DIF: Medium   REF: Section 1.1
    MSC: Remembering
    OBJ: Define the bold-faced vocabulary terms within
    the chapter.

22. According to the figure below, if you were to specify your address in the universe, listing your membership from the smallest to largest physical structures, it would be
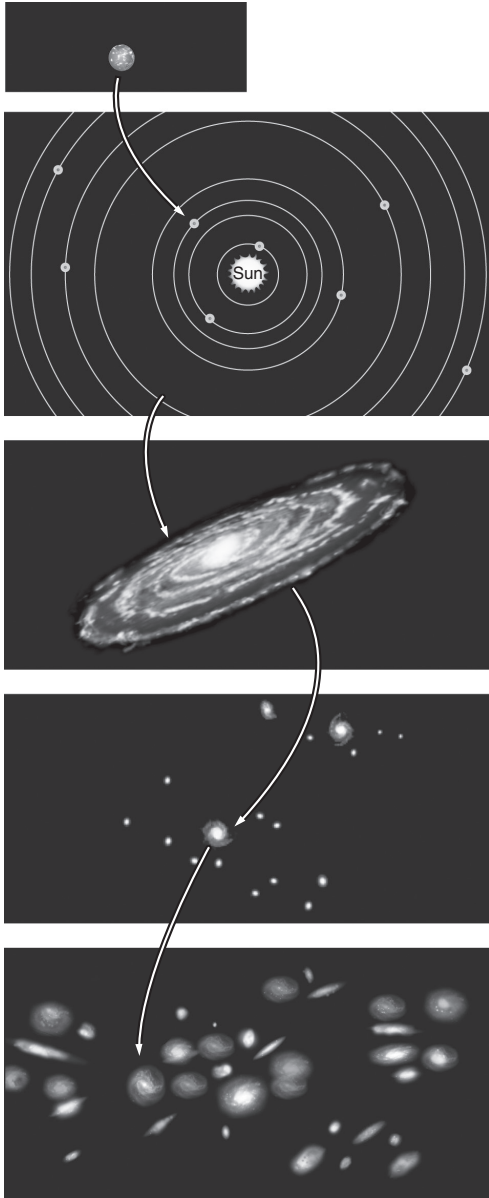
a. Earth, Local Group, Solar System, Andromeda, the universe.
b. Earth, Solar System, Local Group, Milky Way, the universe.
c. Earth, Solar System, Milky Way, Local Group, Laniakea Supercluster, the universe.
d. Earth, Solar System, Milky Way, Laniakea Supercluster, the universe.
e. Earth, Laniakea Supercluster, Milky Way, Solar System, the universe.

ANS: C   DIF: Difficult   REF: Section 1.1
MSC: Understanding
OBJ: List our cosmic address.

23. Which of the following is *false*?
    a. The Local Group is a member of the Laniakea Supercluster, which contains thousands of galaxies.
    b. The Local Group contains two large spiral galaxies and a few dozen dwarf galaxies.
    c. Our Solar System has eight classical planets.
    d. The Milky Way Galaxy contains approximately 100 million stars.
    e. The Laniakea Supercluster is one of many superclusters in the universe.

ANS: D   DIF: Difficult   REF: Section 1.1
MSC: Understanding
OBJ: Differentiate the various components of our cosmic address.

24. If the diameter of the Milky Way is approximately 100,000 light-years, then our galaxy is _____ times larger than our Solar System. For reference, Pluto's orbit has an approximate diameter of 80 astronomical units (AU).
    a. 100
    b. 1,000
    c. 10,000
    d. 10^6
    e. 10^8

ANS: E   DIF: Difficult   REF: Section 1.1
MSC: Applying
OBJ: Relate the different sizes of, or the different distances between, the components of our cosmic address.

25. The majority of the energy in our universe is
    a. radiated by stars from the nuclear fusion going on in their cores.
    b. the kinetic energy found in the collisions of galaxies.
    c. the gravitational potential energy of superclusters.
    d. emitted in radioactive decays of unstable elements.
    e. made up of dark energy that permeates space.

ANS: E   DIF: Difficult   REF: Section 1.1
MSC: Remembering
OBJ: Relate the different sizes of, or the different distances between, the components of our cosmic address.

26. After the Sun, the next nearest star to us is approximately _____ away.
    a. 8 light-seconds
    b. 80 light-minutes
    c. 40 light-hours
    d. 4 light-years
    e. 200 light-years

    ANS: D   DIF: Medium   REF: Section 1.1
    MSC: Remembering
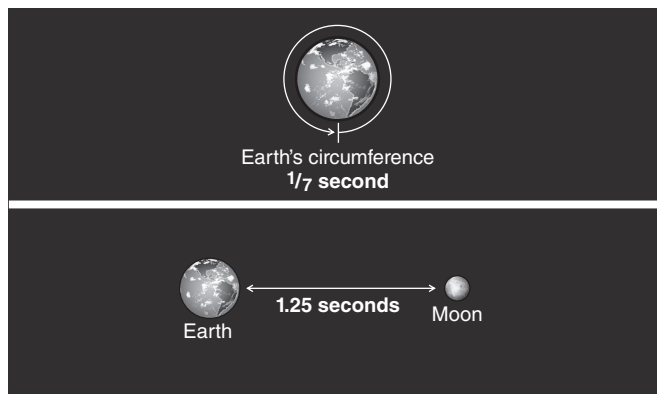   OBJ: Relate astronomical distances with light-travel time.

27. The figure below measures distances in the amount of time it takes light to travel. If the circumference of Earth is a snap of your fingers (1/7 second), the diameter of the Solar System is approximately equal to

Earth's circumference
1/7 second

1.25 seconds
Earth   Moon

    a. the length of a quick lunch.
    b. the time to turn a page in a book.
    c. the length of the work day.
    d. the time you spent in high school.
    e. a human lifetime.

    ANS: C   DIF: Difficult   REF: Section 1.1
    MSC: Applying
    OBJ: Relate astronomical distances with light-travel time.

28. If you compared the diameter of Earth, which is 13,000 km, to 1 second, then what unit of time would be equivalent to the size of the Milky Way, whose diameter is 10^{21} m, and what significant milestone would this time correspond to in our evolution?
    a. 2 million years, the length of time humans have existed on Earth
    b. 30,000 years, the length of time humans have lived in North America
    c. 400 years, the length of time humans have been exploring the skies with telescopes
    d. 4 billion years, the age of the Solar System
    e. 14 billion years, the age of the universe

    ANS: A   DIF: Difficult   REF: Section 1.1
    MSC: Applying
    OBJ: Relate astronomical distances with light-travel time.

29. _____ is the idea that the simplest explanation for a phenomenon is usually the correct one.
    a. Newton's hypothesis
    b. Occam's razor
    c. Aristotle's test
    d. Einstein's excuse
    e. The Copernican principle

    ANS: B   DIF: Easy   REF: Section 1.2
    MSC: Remembering
    OBJ: Define the bold-faced vocabulary terms within the chapter.

30. A scientific theory can be shown to be wrong if
    a. cultural beliefs evolve to contradict it.
    b. scientists gather new data that contradict its predictions.
    c. it cannot explain all phenomena.
    d. it was first proposed as a conjecture.
    e. a majority of people do not accept it.

    ANS: B   DIF: Easy   REF: Section 1.2
    MSC: Understanding
    OBJ: Establish why all scientific knowledge is provisional.

31. Albert Einstein is best known for his revolutionary theory of
    a. relativity.
    b. quantum mechanics.
    c. astronomy.
    d. electricity.
    e. mathematics.

    ANS: A   DIF: Easy   REF: Section 1.2
    MSC: Remembering
    OBJ: Define the bold-faced vocabulary terms within the chapter.

32. In science an idea that cannot be tested is
    a. a hypothesis.
    b. not a scientific idea.
    c. a theory.
    d. a principle.

    ANS: B   DIF: Easy   REF: Section 1.2
    MSC: Remembering
    OBJ: Compare an *idea* with a *hypothesis*.

33. A theory is
    a. tied to known physical laws.
    b. able to make testable predictions.
    c. a hypothesis that has withstood many attempts to falsify it.
    d. all of the above

    ANS: D   DIF: Easy   REF: Section 1.2
    MSC: Remembering
    OBJ: Compare the everyday and scientific meanings of *theory*.

34. A hypothesis is an idea that is
    a. falsifiable with current technology only.
    b. potentially falsifiable with future technology.
    c. not falsifiable.
    d. both a and b

    ANS: D   DIF: Easy   REF: Section 1.2
    MSC: Understanding
    OBJ: Compare an *idea* with a *hypothesis*.

35. A hypothesis may become a theory
    a. after many repeated attempts to falsify it fail.
    b. if a majority of scientists agree on its propositions.
    c. after it has been logically proved.
    d. if it makes at least one verifiable prediction.

    ANS: A   DIF: Easy   REF: Section 1.2
    MSC: Remembering
    OBJ: Compare the everyday and scientific meanings of *theory*.

36. A theoretical model is
    a. a made-up explanation.
    b. a detailed description in terms of known physical laws or theories.
    c. a testable assumption.
    d. a scientific law.

    ANS: B   DIF: Easy   REF: Section 1.2
    MSC: Remembering
    OBJ: Define the bold-faced vocabulary terms within the chapter.

37. A scientific principle is
    a. a scientific law.
    b. a detailed description in terms of known physical laws or theories.
    c. a general idea or sense about the universe.
    d. a testable statement.

    ANS: B   DIF: Easy   REF: Section 1.2
    MSC: Remembering
    OBJ: Define the bold-faced vocabulary terms within the chapter.

38. In the scientific method, if an observation does not support the hypothesis, what possible actions should happen next?
    a. Make additional predictions.
    b. Make more observations.
    c. Choose a new hypothesis or revise the current one.
    d. Both b and c

    ANS: D   DIF: Medium   REF: Section 1.2
    MSC: Remembering
    OBJ: Describe the steps of the scientific method.

39. Which of the following is *false*?
    a. A scientific theory is an undisputed fact.
    b. If continual testing of a hypothesis shows it to be valid, it may become an accepted theory.
    c. A hypothesis must always have one or more testable predictions.
    d. A scientific theory may eventually be proven wrong when scientists acquire new data.
    e. Scientific observations are used to test a hypothesis.

    ANS: A   DIF: Medium   REF: Section 1.2
    MSC: Analyzing
    OBJ: Compare the everyday and scientific meanings of *theory*.

40. The scientific method is a process by which scientists
    a. prove theories to be known facts.
    b. gain confidence in theories by failing to prove them wrong.
    c. show all theories to be wrong.
    d. test the ideas of Aristotle.
    e. survey what the majority of people think about a theory.

    ANS: B   DIF: Medium   REF: Section 1.2
    MSC: Applying
    OBJ: Define the bold-faced vocabulary terms within the chapter.

41. A _____ becomes a _____ when repeated testing of its predictions does not disprove it.
    a. hypothesis; scientific method
    b. theory; scientific revolution
    c. phenomenon; theory
    d. hypothesis; theory
    e. law; theory

    ANS: D   DIF: Medium   REF: Section 1.2
    MSC: Applying
    OBJ: Describe the steps of the scientific method.

42. The cosmological principle states that
    a. the universe is expanding in all directions at the same rate.
    b. a unique center of the universe exists.
    c. the universe looks the same everywhere and in all directions as long as you look on large enough spatial scales.
    d. physical laws change from place to place in the universe.
    e. the universe is in a "steady state."

    ANS: C   DIF: Medium   REF: Section 1.2
    MSC: Remembering
    OBJ: Define the bold-faced vocabulary terms within the chapter.

43. Because of _____, we can conclude that gravity works the same way on Earth as it does on Mars.
    a. Newton's theory of relativity
    b. Einstein's special theory of relativity
    c. Sagan's planetary principle
    d. the cosmological principle
    e. the hypothetical statute

    ANS: D   DIF: Medium   REF: Section 1.2
    MSC: Applying
    OBJ: Define the bold-faced vocabulary terms within the chapter.

44. If you have a stuffy nose, a fever, chills, and body aches and a doctor treats you for the flu rather than four separate diseases that account for each of your symptoms, this is an application of
    a. Newton's hypothesis
    b. Occam's razor
    c. Aristotle's test
    d. Einstein's relativity
    e. Copernican principle

    ANS: B   DIF: Difficult   REF: Section 1.2
    MSC: Applying
    OBJ: Define the bold-faced vocabulary terms within the chapter.

45. One of the central assumptions in astronomy is that the physical laws of nature
    a. change when objects move at high speed.
    b. change throughout the age of the universe.
    c. depend on the mass of the objects involved.
    d. are the same everywhere in the universe.

    ANS: D   DIF: Medium   REF: Section 1.2
    MSC: Remembering
    OBJ: Assess whether a given idea or explanation is scientific.

46. The statement "our universe is but one of a multitude of isolated universes" is best characterized as a
    a. speculative but unscientific idea because it is not testable and therefore not falsifiable.
    b. scientific fact.
    c. physical law.
    d. hypothesis that is currently being tested.

    ANS: A   DIF: Difficult   REF: Section 1.2
    MSC: Applying
    OBJ: Assess whether a given idea or explanation is scientific.

47. The language of science is
    a. Greek
    b. mathematics
    c. calculus
    d. Java
    e. Latin

    ANS: B   DIF: Easy   REF: Section 1.3
    MSC: Remembering
    OBJ: Identify patterns in nature.

48. When you see a pattern in nature, it is usually evidence of
    a. a theory being displayed.
    b. quantum mechanics in action.
    c. a breakdown of random clustering.
    d. an underlying physical law.
    e. A decrease in entropy.

    ANS: D   DIF: Easy   REF: Section 1.3
    MSC: Understanding
    OBJ: Identify patterns in nature.

49. Scientific notation is used in astronomy primarily because it allows us to
    a. write very large and very small numbers in a convenient way.
    b. talk about science in an easy way.
    c. change easy calculations into hard calculations.
    d. change hard calculations into easy calculations.
    e. explain science to engineers.

    ANS: A   DIF: Easy   REF: Working It Out 1.1
    MSC: Remembering
    OBJ: Write numbers in both scientific and standard notation.

50. Which is an important element in the composition of your body that was produced by nuclear fusion inside a star or an explosion of a star?
    a. iron
    b. calcium
    c. oxygen
    d. carbon
    e. all of the above

    ANS: E   DIF: Easy   REF: Section 1.3
    MSC: Remembering
    OBJ: Summarize the evidence for the statement "We are actually made of recycled stardust."

51. The figure below shows the night sky as it appears for an observer in the United States at the same time of the night but at four different seasons of the year. Which conclusion below is *not* reasonable based on these observations?

Summer

Spring

Fall

Winter

a. Constellations do not change their location relative to one another, but which constellations appear in the night sky does change from season to season.
b. There are some constellations such as Ursa Minor, Ursa Major, Cassiopeia, and Cephus that are always seen in the night sky.
c. Some constellations such as Capricornus and Sagittarius are only visible during summer and fall.
d. A good time to harvest crops would be when the constellation Pegasus is directly overhead.
e. A good time to plant crops would be when the constellation Sagittarius is directly overhead.

ANS: E   DIF: Medium   REF: Section 1.3
MSC: Applying
OBJ: Identify patterns in nature.

52. Which presently observed element or isotope was *not* produced in appreciable amounts in the very early universe shortly after the Big Bang?
a. hydrogen
b. helium-4
c. deuterium
d. carbon
e. helium-3

ANS: D   DIF: Medium   REF: Section 1.3
MSC: Applying
OBJ: Summarize the evidence for the statement "We are actually made of recycled stardust."

10   •   CHAPTER 1

53. The study of whether or not life exists elsewhere in the Solar System and beyond is called
    a. origins.
    b. biochemistry.
    c. cosmology.
    d. astrobiology.
    e. exoplanetology.

    ANS: D   DIF: Medium   REF: Section 1.3
    MSC: Remembering
    OBJ: Identify fields of science that relate to the study of origins.

54. The most massive elements such as those that make up terrestrial planets like Earth were formed
    a. in the early universe.
    b. inside stars and supernovae.
    c. through meteor collisions.
    d. in the core of Earth.
    e. during the formation of the Solar System.

    ANS: B   DIF: Medium   REF: Section 1.3
    MSC: Remembering
    OBJ: Summarize the evidence for the statement "We are actually made of recycled stardust."

55. The number 123,000 written in scientific notation is
    a. 1.23×10^6
    b. 1.23×10^5
    c. 1.23×10^3
    d. 1.23×10^{-6}
    e. 1.23×10^3

    ANS: B   DIF: Easy   REF: Working It Out 1.1
    MSC: Applying
    OBJ: Write numbers in both scientific and standard notation.

56. If the radius of circle B is twice the radius of circle A, and the area of a circle is proportional to the radius squared ($A \propto r^2$), then the ratio of the area of circle B to that of circle A is
    a. 4.
    b. 0.5.
    c. 0.25.
    d. 2.
    e. 1.414.

    ANS: A   DIF: Easy   REF: Working It Out 1.1
    MSC: Applying
    OBJ: Describe characteristics of real-world objects in terms of ratios.

57. $(6 \times 10^5) \times (3 \times 10^{-2}) =$
    a. 1.8×10^3
    b. 1.8×10^4
    c. 1.8×10^6
    d. 1.8×10^8
    e. 1.8×10^{-3}

    ANS: B   DIF: Medium   REF: Working It Out 1.1
    MSC: Applying
    OBJ: Write numbers in both scientific and standard notation.

58. $(1.2 \times 10^9) \div (4 \times 10^{-3}) =$
    a. 3×10^6
    b. 3×10^5
    c. 3×10^{10}
    d. 3×10^{11}
    e. 3×10^{12}

    ANS: D   DIF: Medium   REF: Working It Out 1.1
    MSC: Applying
    OBJ: Write numbers in both scientific and standard notation.

59. If the radius of circle B is 5 times the radius of circle A, then the ratio of the area of circle B to that of circle A is
    a. 25.
    b. 5.
    c. 0.2.
    d. 0.04.
    e. 0.025.

    ANS: A   DIF: Medium   REF: Working It Out 1.1
    MSC: Applying
    OBJ: Describe characteristics of real-world objects in terms of ratios.

60. If the radius of sphere B is 5 times the radius of sphere A, then the ratio of the volume of sphere B to the volume of sphere A is
    a. 0.008.
    b. 0.2.
    c. 5.
    d. 25.
    e. 125.

    ANS: E   DIF: Medium   REF: Working It Out 1.1
    MSC: Applying
    OBJ: Describe characteristics of real-world objects in terms of ratios.

61. The area of a circle is related to its diameter by the formula $A = \frac{1}{4}\pi D^2$. Using algebra to solve for D, we find that

a. $D = \left(\frac{4A}{\pi}\right)^2$.

b. $D = \left(\frac{\pi}{4A}\right)^2$.

c. $D = \left(\frac{\pi}{4A}\right)^{1/2}$.

d. $D = \left(\frac{4A}{\pi}\right)^{1/2}$.

e. $D = \left(\frac{4A}{\pi}\right)$.

ANS: D   DIF: Medium   REF: Working It Out 1.1
MSC: Applying
OBJ: Determine the mathematical behavior of proportional systems.

62. The volume of a sphere is related to its radius by the formula $V = \frac{4}{3}\pi R^3$. Using algebra to solve for R, we get

a. $R = \left(\frac{4\pi V}{3}\right)^{1/3}$.

b. $R = \left(\frac{3V}{4(\pi)}\right)^{1/3}$.

c. $R = \left(\frac{4\pi}{3V}\right)^{1/3}$.

d. $R = \frac{3}{4(V)^3}$.

e. $R = \left(\frac{4\pi V}{3}\right)^3$.

ANS: B   DIF: Difficult   REF: Working It Out 1.1
MSC: Applying
OBJ: Determine the mathematical behavior of proportional systems.

63. If the speed of light is 3×10^5 km/s and 1 km = 0.62 mile, what is the speed of light in miles per hour (mph)?
a. 670 million mph
b. 670 thousand mph
c. 186 mph
d. 186 thousand mph
e. 3.2 billion mph

ANS: A   DIF: Difficult   REF: Working It Out 1.1
MSC: Applying
OBJ: Determine the mathematical behavior of proportional systems.

64. The orbital period of Mercury is 88 days. What is its orbital period in units of seconds?
a. 76000 seconds
b. 7.6 million seconds
c. 7.6 billion seconds
d. 760 billion seconds
e. 76 million seconds

ANS: B   DIF: Difficult   REF: Working It Out 1.1
MSC: Applying
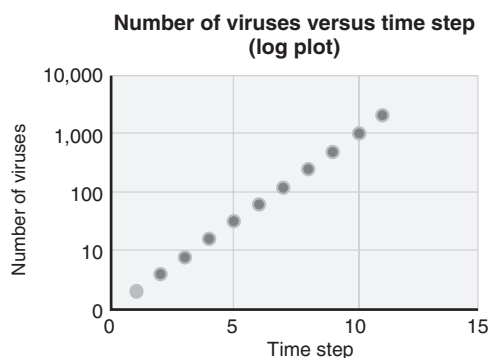OBJ: Determine the mathematical behavior of proportional systems.

65. At a time step of 10 shown in the figure below, how many viruses are there?
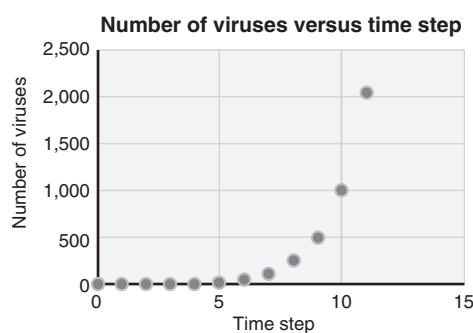
a. 500
b. 1000
c. 1500
d. 2000

ANS: B   DIF: Easy   REF: Working It Out 1.2
MSC: Understanding
OBJ: Read data from linear and logarithmic graphs.

66. Approximately how many viruses are at time step 5 in the figure below?
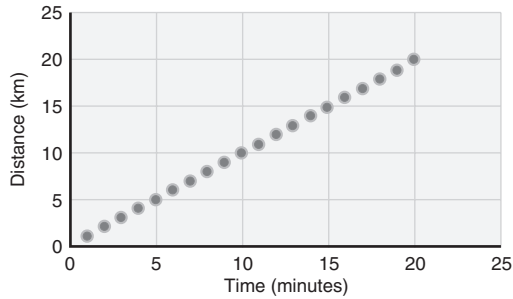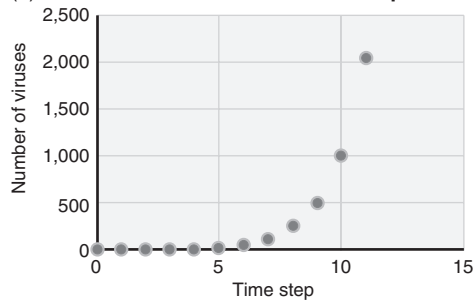

a. 10
b. 30
c. 50
d. 90
e. 100

ANS: C   DIF: Difficult   REF: Working It Out 1.2
MSC: Understanding
OBJ: Read data from linear and logarithmic graphs.

67. Which graph (a), (b), or (c) in the figures below is a plot of an exponential behavior?
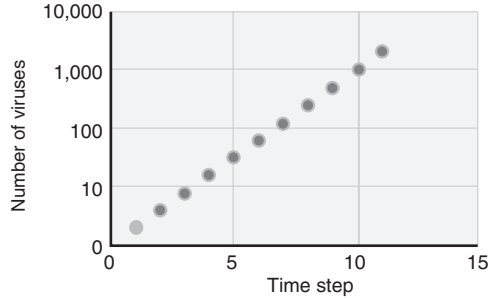
(a) **Distance versus time for a car**

(b) **Number of viruses versus time step**

(c) **Number of viruses versus time step (log plot)**

a. figure (a)
b. figure (b)
c. figure (c)
d. both a and c
e. both b and c

ANS: E   DIF: Medium   REF: Working It Out 1.2
MSC: Understanding
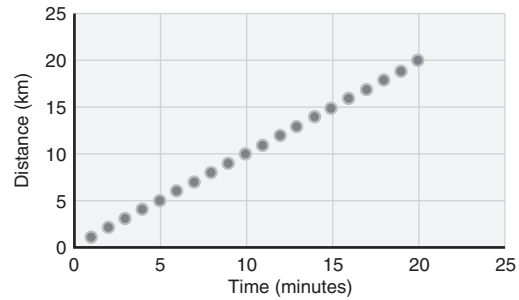OBJ: Distinguish between linear and exponential curves on a graph.

68. The number 1.5×10^4 is:
    a. 0.00015
    b. 0.0015
    c. 1500
    d. 15000
    e. 150000

ANS:D   DIF: Easy   REF: Working It Out 1.1
MSC: Understanding
OBJ: Write numbers in both scientific and standard notation.

69. What are the units of the vertical axis?

(a) **Distance versus time for a car**
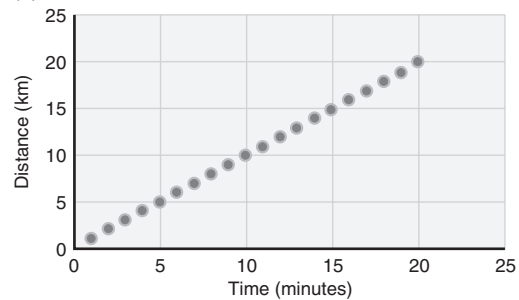

a. km
b. hour
c. km/hour
d. hour/km

ANS: B   DIF: Easy   REF: Working It Out 1.2
MSC: Understanding
OBJ: Identify the x and y axes on a graph.

70. What is the slope of line?

(a) **Distance versus time for a car**

a. 1 km/hour
b. 1 hour/km
c. 10 km/hour
d. 10 hour/km

ANS: D   DIF: Easy   REF: Working It Out 1.2
MSC: Understanding
OBJ: Define slope on a graph.

SHORT ANSWER

1. What is the *only* thing that makes the Sun an exceptional star?

   ANS: The fact that it is *our* star!   DIF: Easy
   REF: Section 1.1   MSC: Remembering
   OBJ: Differentiate the various components of our cosmic address.

2. Why might the universe be described as a sort of "time machine"?

   ANS: The finite speed of light means that objects observed at larger distances are observed as they existed further in the past.
   DIF: Easy   REF: Section 1.1   MSC: Remembering
   OBJ: Relate astronomical distances with light-travel time.

3. What is the Local Group?

   ANS: The group of a dozen or so galaxies including the Milky Way that are within a few million light-years of each other.
   DIF: Easy   REF: Section 1.1   MSC: Remembering
   OBJ: Differentiate the various components of our cosmic address.

4. Describe how talking about time can give us a feeling for distance.

   ANS: If speed is constant, a difference in time is directly related to a difference in distance. A time difference is easier to conceptualize.
   DIF: Medium   REF: Section 1.1
   MSC: Understanding
   OBJ: Relate astronomical distances with light-travel time.

5. Suppose you were writing to a pen pal in another universe. What address would you put on the envelope that included all the major structures in which we reside? (Hint: Your cosmic address should begin with "Earth" and end with "the universe.")

   ANS: The address would be Earth, Solar System, Milky Way, Local Group, Laniakea Supercluster, the universe.
   DIF: Medium   REF: Section 1.1
   MSC: Remembering
   OBJ: List our cosmic address.

6. What would you say to someone who said, "It would take light-years to get to the Andromeda Galaxy"?

   ANS: You would have to tell them that light-years is a unit of distance not time.
   DIF: Medium   REF: Section 1.1   MSC: Applying
   OBJ: Relate astronomical distances with light-travel time.

7. If you compare the diameter of Earth to 1 minute of time, then what interval of time would represent the diameter of the Solar System? Assume the diameter of the Solar System is approximately 80 AU.

   ANS: The diameter of Earth is $2 \times 6{,}378$ km $= 1.3 \times 10^7$ m, and 80 AU $= 80 \times 1.5 \times 10^{11}$ m $= 1.2 \times 10^{13}$ m. Thus, the diameter of the Solar System would be represented by 1.2×10^{13} m $\times$ (1 minute)$/(1.3 \times 10^7$ m$) = 9.4 \times 10^5$ minutes $= 1.8$ years.
   DIF: Difficult   REF: Section 1.1   MSC: Analyzing
   OBJ: Illustrate the size or history of the universe with scaled models.

8. Using the method of comparing times to get a handle on the large distances in astronomy, compare the size of Earth to the size of the visible universe. Start by making the size of Earth comparable to a snap of your fingers, which lasts about 1/7 second. Show your computation.

   ANS: If the size of Earth is like a snap of your fingers (1/7 second), the size of the visible universe would be 13.7 billion years $\approx 3 \times 4.5$ billion years $= 3$ times the age of the Solar System.
   DIF: Medium   REF: Section 1.1   MSC: Analyzing
   OBJ: Illustrate the size or history of the universe with scaled models.

9. Using the method of comparing distances to time intervals to get a handle on the large distances in astronomy, compare the diameter of our Solar System, which is 6×10^{12}, to the diameter of the galaxy, which is 1.2×10^{21}, by calculating the time it would take for light to travel these diameters. For reference, the speed of light is 3×10^8 m/s.

   ANS: The time it takes light to travel across the diameter of the Solar System is t 5 d/v 5 6 3 1012 m/(3 3 108 m/s) 5 20,000 s 3 (1 h/3600 s) 5 5.5 h. The time it takes light to travel across the diameter of the galaxy is t 5 1.2 3 1021 m/(3 3 108 m/s) 5 4 3 1012 s 3 (1 h/3600 s) 3 (1 day/24 h) 3 (1 y/365 day) 5 130,000 y.
   DIF: Difficult   REF: Section 1.1   MSC: Analyzing
   OBJ: Illustrate the size or history of the universe with scaled models.

10. What implication does the finite speed of light have on what we observe in the universe?

    ANS: It means we see objects as they were when the light left them. Looking further away from Earth is also looking further back in time.
    DIF: Difficult REF: Section 1.1 MSC: Applying
    OBJ: Relate astronomical distances with light-travel time.

11. Describe the two main aspects of the cosmological principle.

    ANS: (1) What we see around us is representative of what the universe is like in general, and (2) the physical laws valid on Earth are valid everywhere.
    DIF: Easy REF: Section 1.2
    MSC: Remembering
    OBJ: Define the bold-faced vocabulary terms within the chapter.

12. What makes an idea a hypothesis?

    ANS: A hypothesis must be a falsifiable idea.
    DIF: Easy REF: Section 1.2
    MSC: Remembering
    OBJ: Compare an *idea* with a *hypothesis*.

13. Why is the statement "The Big Bang was caused by a collision between other universes" not scientific?

    ANS: The statement is not scientific because it is not testable.
    DIF: Easy REF: Section 1.2
    MSC: Applying
    OBJ: Assess whether a given idea or explanation is scientific.

14. An observation does not support your hypothesis. What do you do next?

    ANS: Make more observations, revise the hypothesis, or choose a new hypothesis.
    DIF: Easy REF: Section 1.2
    MSC: Understanding
    OBJ: Describe the steps of the scientific method.

15. Before 2014 the supercluster we resided in was called the Virgo Supercluster. Based on a new way of classifying superclusters we are now a member of the Laniakea Supercluster. What is this change an example of?

    ANS: The provisional nature of scientific knowledge.
    DIF: Easy REF: Section 1.2
    MSC: Understanding
    OBJ: Establish why all scientific knowledge is provisional.

16. What accounts for 95 percent of the mass of the universe?

    ANS: Dark matter and dark energy, the latter having an equivalent mass are related by $E = mc^2$.
    DIF: Easy REF: Section 1.1
    MSC: Remembering
    OBJ: Relate the different sizes of, or the different distances between, the components of our cosmic address.

17. What is a theoretical model?

    ANS: A theoretical model is a detailed description of the properties of a particular system in terms of known physical laws or theories, which can be used to make predictions.
    DIF: Easy REF: Section 1.2
    MSC: Remembering
    OBJ: Define the bold-faced vocabulary terms within the chapter.

18. In pre-Renaissance times, it was believed that celestial objects were made of a different substance than Earth and obeyed different rules. Which modern scientific principle is a better description of the universe?

    ANS: The cosmological principle.
    DIF: Medium REF: Section 1.2 MSC: Applying
    OBJ: Define the bold-faced vocabulary terms within the chapter.

19. Why does a theory that continues to be supported by the results of experimental tests need further tests?

    ANS: There may be observational tests or measurements that might be performed with greater precision for which the predictions of the theory might fail.
    DIF: Medium REF: Section 1.2
    MSC: Remembering
    OBJ: Establish why all scientific knowledge is provisional.

20. Describe the main steps involved in the scientific method.

    ANS: First you make a hypothesis and then you make a prediction based on your hypothesis. Finally, you test your prediction through experimentation to prove or disprove your original hypothesis. You revise your hypothesis, if necessary, when the experiments disagree with your hypothesis.
    DIF: Medium   REF: Section 1.2
    MSC: Understanding
    OBJ: Describe the steps of the scientific method.

21. What two pre-Renaissance beliefs are contradicted by the cosmological principle?

    ANS: (1) Earth is at the center of our universe, and (2) celestial objects are made of a different substance than Earth and obey different rules.
    DIF: Medium   REF: Section 1.2
    MSC: Remembering
    OBJ: Establish why all scientific knowledge is provisional.

22. Describe two ways in which Einstein's new theories changed commonly accepted scientific views of his time.

    ANS: Mass and energy are manifestations of the same phenomenon. Thus, you can convert one into the other. Time and space are not separable but are intimately related to one another. Thus, Newton's law of gravity is only a special case of a more general law Einstein called general relativity. However, Newton's law of gravity is much easier for most calculations in our day-to-day lives.
    DIF: Medium   REF: Section 1.2
    MSC: Understanding
    OBJ: Establish why all scientific knowledge is provisional.

23. How would you respond to someone who stated that "Evolution is not proven; it is just a theory"?

    ANS: You would need to explain that in science, a theory is not something that is proven; rather it our best explanation based on available data. Thus, calling something a theory does not diminish its importance.
    DIF: Difficult   REF: Section 1.2   MSC: Applying
    OBJ: Compare the everyday and scientific meanings of *theory*.

24. There are many different areas of science, but a common factor in each is the evaluation and analysis of patterns. What patterns does astronomy deal with? (Describe it in general and give at least one concrete example.)

    ANS: Astronomy deals with patterns related to celestial objects. One example is that patterns in the sky mark the changing of seasons, the coming of rains, the movement of herds, and the planting and harvesting of crops. An additional example is that the Sun rises and sets at a specific time because Earth orbits the Sun.
    DIF: Easy   REF: Section 1.3
    MSC: Understanding
    OBJ: Identify patterns in nature.

25. An observed pattern in nature is usually a sign of some underlying physical reason. Give an example of this in astronomy, citing the pattern and the reason behind it.

    ANS: The Sun rises and sets each day. This pattern is due to Earth's daily rotation on its axis. The stars visible in the sky at a given time of day change throughout the year, but the pattern repeats every year. This is due to Earth's orbital motion around the Sun in 1 year.
    DIF: Easy   REF: Section 1.3   MSC: Applying
    OBJ: Identify patterns in nature.

26. It is often said that "mathematics is the language of science." Explain why this is true.

    ANS: Math is a formal system used when describing and analyzing patterns, and explaining the reasons for patterns is the heart of science. Thus, math is the language of science.
    DIF: Easy   REF: Section 1.3
    MSC: Understanding
    OBJ: Identify patterns in nature.

27. If the elements that make up Earth and our bodies were not present in the early universe, where did they come from?

    ANS: They were formed by nuclear fusion inside stars.
    DIF: Easy   REF: Section 1.3   MSC: Applying
    OBJ: Summarize the evidence for the statement "We are actually made of recycled stardust."

28. What is the field of science that relates to the study of origin of life?

    ANS: Astrobiology.   DIF: Easy   REF: Section 1.3
    MSC: Remembering
    OBJ: Identify fields of science that relate to the study of origins.

29. Describe briefly why the phrase "we are stardust" is literally true.

    ANS: Massive stars make heavy elements during their lifetime. When they eventually explode in a supernova, some of these heavy elements, as well as additional ones that are created in the explosion itself, are ejected into space, where they eventually cool and condense to form new solar systems and everything in them, including us.
    DIF: Medium   REF: Section 1.3
    MSC: Understanding
    OBJ: Summarize the evidence for the statement "We are actually made of recycled stardust."

30. Life as we know it requires the heavy elements made in stars. Could life as we know it have existed when the first stars in the universe formed?

    ANS: The heavy elements that make up our bodies were not yet formed, so life as we know it would have been impossible.
    DIF: Difficult   REF: Section 1.3
    MSC: Understanding
    OBJ: Summarize the evidence for the statement "We are actually made of recycled stardust."