

The Cosmic Perspective, 8e (Bennett)
Chapter 3 The Science of Astronomy

3.1 Multiple-Choice Questions

- 1) People of central Africa predicted the weather by
- A) recording the seasonal changes in average temperature.
 - B) observing the path of the planets across the sky.
 - C) observing the length of the lunar cycle.
 - D) observing the orientation of the crescent Moon relative to the horizon.
 - E) observing the location of the Moon relative to the Sun in the sky.

Answer: D

- 2) The names of the seven days of the week are based on the
- A) seven naked-eye objects that appear to move among the constellations.
 - B) seven planets closest to the Sun.
 - C) seven brightest stars in the prominent constellation Orion.
 - D) most popular Norse gods.
 - E) seven largest constellations of the ancient world.

Answer: A

- 3) Suppose the planet Uranus were much brighter in the sky, so that it was as easily visible to the naked eye as Jupiter or Saturn. Which one of the following statements would *most likely* be true in that case?
- A) Its brightness would make it possible to read by starlight at night.
 - B) Its gravity would cause the tides to be much higher than they actually are.
 - C) Its slow motion through the sky would have led it to be named after the Goddess of Procrastination.
 - D) The discovery that Earth is a planet going around the Sun would have come hundreds of years earlier.
 - E) A week would have eight days instead of seven, despite the year length being unchanged.

Answer: E

- 4) Compared with the standard *hour* of 60 minutes used today, the *hour* of ancient Egypt
- A) was longer than the *hour* used today.
 - B) was shorter than the *hour* used today.
 - C) differed in length depending on the pharaoh in power at the time.
 - D) was longer than 60 minutes in the summer and shorter than 60 minutes in the winter.
 - E) divided the entire day into 12 equal parts.

Answer: D

- 5) In order to tell time at night, the ancient Egyptians of 3000 B.C. used
- A) sundials, with light provided by the Moon.
 - B) water clocks, measuring the flow of water through an opening.
 - C) hourglasses, measuring the flow of sand through an opening.
 - D) Moon clocks, which measured time based on the Moon's position relative to the stars.
 - E) star clocks, which measured time based on the positions of stars at particular times of night and particular times of year.

Answer: E

- 6) Historians trace the origins of a 24-hour day to
- A) the druids of Stonehenge.
 - B) the ancient Egyptians.
 - C) the Mayans.
 - D) the Aztecs.
 - E) the Babylonian astronomer, Meton.

Answer: B

- 7) What do the structures of Stonehenge, the Templo Mayor, and the Sun Dagger all have in common?

- A) They were all places used for religious sacrifice.
- B) They were all built on the orders of ancient Mediterranean kings.
- C) They all can be used as lunar calendars.
- D) They were all used by ancient peoples for astronomical observations.
- E) all of the above

Answer: D

- 8) At the Sun Dagger in New Mexico, a dagger-shaped beam of sunlight pierces a spiral

- A) every day at noon.
- B) at noon on the summer solstice.
- C) at sunset on the spring equinox.
- D) at noon on the day of full Moon each month.
- E) during the totality of a total solar eclipse.

Answer: B

- 9) The Muslim fast of Ramadan occurs

- A) on the summer solstice.
- B) during the ninth month of a 12-month lunar cycle.
- C) on the spring equinox.
- D) during a thirteenth month of the Metonic cycle.
- E) at the end of the Metonic cycle.

Answer: B

- 10) The *Metonic cycle* is the
- A) 29 1/2-day period of the lunar cycle.
 - B) 12-month period of a lunar calendar.
 - C) 19-year period over which the lunar phases occur on about the same dates.
 - D) 18-year, 11-day period over which the pattern of eclipses repeats.
 - E) period between successive Easters.

Answer: C

- 11) The Jewish calendar is kept roughly synchronized with a solar calendar by
- A) adding a thirteenth lunar month to 7 out of every 19 years.
 - B) having a thirteenth month with 5 days each year.
 - C) skipping a month every 7 out of 19 years.
 - D) having the first lunar month begin on the spring equinox.
 - E) having the first lunar month begin on the summer solstice.

Answer: A

- 12) Which ancient culture had the greatest known success in predicting eclipses?
- A) Aztecs
 - B) Mayans
 - C) Egyptians
 - D) Babylonians
 - E) Greeks

Answer: B

- 13) The path that led to modern science emerged from ancient civilizations in which part of the world?
- A) Central and South America
 - B) the Mediterranean and the Middle East
 - C) North America
 - D) China
 - E) Southern Asia

Answer: B

- 14) When and where did the Library of Alexandria exist?
- A) from A.D. 600 to A.D. 1800 in Greece
 - B) from A.D. 600 to A.D. 1800 in Egypt
 - C) from 300 B.C. to A.D. 400 in Rome
 - D) from 300 B.C. to A.D. 400 in Greece
 - E) from 300 B.C. to A.D. 400 in Egypt

Answer: E

15) How did Eratosthenes estimate the size of Earth in 240 B.C.?

- A) by observing the duration of a solar eclipse
- B) by measuring the size of Earth's shadow on the Moon in a lunar eclipse
- C) by comparing the maximum altitude of the Sun in two cities at different latitudes on the summer solstice
- D) by sending fleets of ships around Earth
- E) We don't know how he did it since all his writings were destroyed.

Answer: C

16) Which of the following statements about scientific models is *true*?

- A) A model tries to represent all aspects of nature.
- B) A model tries to represent only one aspect of nature.
- C) A model can be used to explain and predict real phenomena.
- D) All models that explain nature well are correct.
- E) All current models are correct.

Answer: C

17) Ptolemy was important in the history of astronomy because he

- A) developed a model of the solar system that made sufficiently accurate predictions of planetary positions to remain in use for many centuries.
- B) developed a scientifically accurate model of the universe.
- C) was the first to believe in an Earth-centered universe.
- D) was the first to create a model of the solar system that placed the Sun rather than Earth at the center.
- E) was the first to believe that all orbits are perfect circles.

Answer: A

18) When did Ptolemy live?

- A) about 5000 years ago
- B) about 2000 years ago
- C) about 1000 years ago
- D) about 500 years ago
- E) about 100 years ago

Answer: B

19) How did the Ptolemaic model explain the apparent retrograde motion of the planets?

- A) It held that sometimes the planets moved backward along their circular orbits.
- B) It placed the Sun at the center so that the planets' apparent retrograde motion was seen as Earth passed each one in its orbit.
- C) It varied the motion of the celestial sphere so that it sometimes moved backward.
- D) It held that the planets moved along small circles that moved on larger circles around the Sun.
- E) It held that the planets moved along small circles that moved on larger circles, also known as epicycles, around Earth.

Answer: E

20) Why did Ptolemy have the planets orbiting Earth on "circles upon circles" in his model of the universe?

- A) to explain why more distant planets take longer to make a circuit through the constellations of the zodiac
- B) to explain the fact that planets sometimes appear to move westward, rather than eastward, relative to the stars in our sky
- C) to explain why the Greeks were unable to detect stellar parallax
- D) to properly account for the varying distances of the planets from Earth
- E) to explain why Venus goes through phases as seen from Earth

Answer: B

21) Where was the Sun in Ptolemy's model of the universe?

- A) at the center
- B) slightly offset from the center
- C) between Earth and the Moon's orbit
- D) between the orbits of Venus and Mars
- E) at the outer edge, beyond Saturn's orbit

Answer: D

22) During the Dark Ages in Europe, the scientific work of the ancient Greeks was preserved and further developed primarily by scholars in

- A) Baghdad.
- B) Greece.
- C) Rome.
- D) India.
- E) China.

Answer: A

23) The controversial book of this famous person, published in 1543 (the year of his death), suggested that Earth and other planets orbit the Sun.

- A) Tycho Brahe
- B) Copernicus
- C) Kepler
- D) Galileo
- E) Ptolemy

Answer: B

24) He developed a system for predicting planetary positions that remained in use for some 1,500 years.

- A) Tycho Brahe
- B) Copernicus
- C) Kepler
- D) Galileo
- E) Ptolemy

Answer: E

25) He was the first to prove that comets lie beyond Earth's atmosphere.

- A) Tycho Brahe
- B) Copernicus
- C) Kepler
- D) Galileo
- E) Aristotle

Answer: A

26) He discovered that the orbits of planets are ellipses.

- A) Tycho Brahe
- B) Copernicus
- C) Kepler
- D) Galileo
- E) Ptolemy

Answer: C

27) He discovered that Jupiter has moons.

- A) Tycho Brahe
- B) Aristotle
- C) Kepler
- D) Galileo
- E) Ptolemy

Answer: D

28) He discovered what we now call Newton's first law of motion.

- A) Tycho Brahe
- B) Copernicus
- C) Kepler
- D) Galileo
- E) Ptolemy

Answer: D

29) When Copernicus first created his Sun-centered model of the universe, it did not lead to substantially better predictions of planetary positions than the Ptolemaic model. Why not?

- A) Copernicus misjudged the distances between the planets.
- B) Copernicus misjudged the speeds at which the planets orbit the Sun.
- C) Copernicus placed the planets in the wrong order going outward from the Sun.
- D) Copernicus placed the Sun at the center but did not realize that the Moon orbits Earth.
- E) Copernicus used perfect circles for the orbits of the planets, whereas planets actually have elliptical orbits.

Answer: E

30) When did Copernicus live?

- A) about 5000 years ago
- B) about 2000 years ago
- C) about 1000 years ago
- D) about 500 years ago
- E) about 100 years ago

Answer: D

31) Which of the following was *not* observed by Galileo?

- A) craters on the Moon
- B) stellar parallax
- C) sunspots
- D) Jupiter's moons
- E) phases of Venus

Answer: B

32) One of the "nails in the coffin" for Earth-centered universe was

- A) the retrograde motion of the planets.
- B) the phases of the Moon.
- C) eclipses of the Sun.
- D) Galileo's observation of stars in the Milky Way.
- E) Galileo's observations of the moons of Jupiter.

Answer: E

33) Which of the following is *not* one of, nor follows directly from, Kepler's laws?

- A) The orbit of each planet about the Sun is an ellipse with the Sun at one focus.
- B) As a planet moves around its orbit, it sweeps out equal areas in equal times.
- C) The force of attraction between any two objects decreases with the square of the distance between their centers.
- D) A planet travels faster when it is nearer to the Sun and slower when it is farther from the Sun.
- E) More distant planets move at slower speeds.

Answer: C

34) Kepler's third law, $p^2 = a^3$, means that

- A) a planet's period does not depend on the eccentricity of its orbit.
- B) all orbits with the same semimajor axis have the same period.
- C) the period of a planet does not depend on its mass.
- D) planets that are farther from the Sun move at slower average speeds than nearer planets.
- E) All of the above are correct.

Answer: E

35) From Kepler's third law, a hypothetical planet that is twice as far from the Sun as Earth should have a period of

- A) 1/2 Earth year.
- B) 1 Earth year.
- C) 2 Earth years.
- D) more than 2 Earth years.
- E) It depends on the planet's mass.

Answer: D

36) From Kepler's third law, an asteroid with an orbital period of 8 years lies at an average distance from the Sun equal to

- A) 2 astronomical units.
- B) 4 astronomical units.
- C) 8 astronomical units.
- D) 16 astronomical units.
- E) It depends on the asteroid's mass.

Answer: B

37) Kepler's second law, which states that as a planet moves around its orbit it sweeps out equal areas in equal times, means that

- A) a planet travels faster when it is nearer to the Sun and slower when it is farther from the Sun.
- B) a planet's period does not depend on the eccentricity of its orbit.
- C) planets that are farther from the Sun move at slower average speeds than nearer planets.
- D) the period of a planet does not depend on its mass.
- E) planets have circular orbits.

Answer: A

38) All the following statements are true. Which one follows directly from Kepler's third law?

- A) Venus is more massive than Mercury.
- B) Venus orbits the Sun at a slower average speed than Mercury.
- C) Venus is larger than Mercury.
- D) Venus has a thicker atmosphere than Mercury.

Answer: B

39) What do scientists mean by *verifiable observations*?

- A) statements that a person can, in principle, verify for himself or herself
- B) statements that anyone would agree are obvious
- C) observations that can be interpreted in only one way
- D) observations that a model does not have to predict
- E) observations that support a scientific theory

Answer: A

40) What is meant by a scientific *paradigm*?

- A) a conundrum or unexplained set of facts
- B) a radical change in scientific thought
- C) a generally well-established scientific theory or set of theories
- D) a pseudoscientific idea
- E) a historical theory that has been proved inaccurate

Answer: C

41) What is meant by a *hypothesis*?

- A) a natural phenomenon that requires explanation
- B) an explanation for a phenomenon that makes a prediction
- C) a tentative understanding of a natural phenomenon
- D) a pseudoscientific idea
- E) a historical theory that has been proved inaccurate

Answer: B

42) What is meant by *Occam's Razor*?

- A) a well-designed experiment that clearly shows the differences between two competing theories
- B) a poorly designed experiment that fails to show the difference between two competing theories
- C) the idea that scientists should prefer the simpler of two models that agree equally well with observations
- D) the fine line between science and pseudoscience
- E) the shaving implement of a medieval scholar

Answer: C

43) Which of the following statements about scientific theories is false?

- A) Theories are not taken seriously if they contradict older, more developed, theories.
- B) A theory is a model designed to explain a number of observed facts.
- C) If even a single new fact is discovered that contradicts what we expect according to a particular theory, then the theory must be revised or discarded.
- D) A theory must make predictions that can be checked by observation or experiment.
- E) A theory can never be proved beyond all doubt; we can only hope to collect more and more evidence that might support it.

Answer: A

44) The ancient goal of astrology was to

- A) understand the origin of Earth.
- B) make a more accurate model of the universe.
- C) predict the passing of the seasons.
- D) predict human events.
- E) antagonize astronomers.

Answer: D

- 45) The astrology practiced by those who cast predictive horoscopes can be tested by
- A) asking astrologers if it works.
 - B) asking astronomers if it works.
 - C) counting how many times the predictions come true.
 - D) comparing how often the predictions come true to what would be expected by pure chance.
 - E) polling people to find out what percentage believe their horoscopes to be accurate.

Answer: D

- 46) Which of the following best explains the success of the central African rainfall-prediction technique of observing the waxing crescent Moon?
- A) When the Moon is aligned in a U-shape, it can hold more water, so there is more rain. When it is tilted, it can hold less, so the weather is drier.
 - B) When the Moon is in Capricorn, there is always more tempestuous weather, while when in Pisces, it is just plain rainy.
 - C) Clouds cover part of the Moon's surface, so the smaller the crescent, the more likely it is to rain.
 - D) The Moon's orientation varies seasonally, and so does the weather.
 - E) The Moon causes the tides and affects the weather.

Answer: D

Process of Science: Assume we have data indicating a strong positive correlation between acupuncture treatments and recovery of patients from, say, cocaine addiction. However, let's also assume that every hypothesis we have for a mechanism of action (i.e., *how* acupuncture could work to help cure addiction) can be shown to be false. The patients, however, all claim to know that the acupuncture is what cured them. Which of the following conclusions are supported by our data?

- 47) *Could* acupuncture be responsible for the patients' recovery?
- A) No. If there is no plausible mechanism of action, then clearly acupuncture cannot be responsible for their healing.
 - B) Yes. Just because we don't understand the mechanism doesn't mean the process does not occur.
 - C) No. Acupuncture is not accepted by most medical doctors, therefore it isn't effective.
 - D) Yes. If the patients got better, then the acupuncture must be effective.

Answer: B

- 48) *Must* acupuncture be responsible for the patients' recovery?
- A) No. Acupuncture may be responsible for the healing, or it may not. Correlation does not necessarily imply causation.
 - B) Yes. If the study was run by qualified M.D.s, then we should respect their findings that acupuncture cured these patients.
 - C) No. Acupuncture is hippie, new age stuff, and is not respected by reputable doctors.
 - D) Yes. The patients stated afterwards that they knew it had helped, and these people know their own bodies better than we do.

Answer: A

49) Process of Science: What is Occam's razor?

- A) The idea that scientists should prefer the simpler of two models that agree equally well with observations.
- B) The principle that everyone should agree on a theory before it is considered correct.
- C) A long, steep cliff on Mercury that may have been produced as the planet contracted as it formed.
- D) The principal that any theory can be verified by others.
- E) An unusual implement that Professor Occam uses to remove facial hair.

Answer: A

3.2 True/False Questions

1) The names of the seven days of the week are derived from the names of the bodies of the solar system that are visible to the naked eye.

Answer: TRUE

2) The Polynesian navigators of the South Pacific found their way primarily by observing the position of Polaris in the night sky.

Answer: FALSE

3) The Ptolemaic model of the solar system was useless for predicting planetary positions.

Answer: FALSE

4) Copernicus was the first person to suggest a Sun-centered solar system.

Answer: FALSE

5) Copernicus's model of the solar system gave much better predictions than the model of Ptolemy.

Answer: FALSE

6) In the Ptolemaic system, Venus should not show phases.

Answer: FALSE

7) Galileo found "imperfections" on the Sun in the form of sunspots and "imperfections" on the Moon in the form of mountains and valleys.

Answer: TRUE

8) It is possible for science as a whole to be objective despite the fact that all individual scientists have personal biases and beliefs.

Answer: TRUE

9) Scientific thinking developed only in the past few decades.

Answer: FALSE

10) Scientific theories can *never* be proved true beyond all doubt.

Answer: TRUE

11) A scientific model *must* make a testable prediction.

Answer: TRUE

12) Astronomy and astrology were often practiced together in ancient cultures, and astrology played an important role in the historical development of astronomy.

Answer: TRUE

13) Nonscientific practices that make no claims about how the natural world works do not conflict with science.

Answer: TRUE

14) *Process of Science*: I am doing science when I already know the answer to my scientific question and I am searching for evidence in the natural world strictly to support what I know.

Answer: FALSE

15) *Process of Science*: If any single test of a scientific hypothesis contradicts it, the hypothesis must be revised. (Assume that you've ruled out errors in the testing process; that is, the test result really does contradict the hypothesis.)

Answer: TRUE

3.3 Short Answer Questions

1) How did ancient peoples of central Africa predict the weather?

Answer: They observed the orientation of the crescent Moon relative to the horizon. The orientation of the "horns" is related to rainfall patterns.

2) What is special about the lines in the Nazca Desert of Peru?

Answer: There are more than 800 lines etched in the Nazca Desert of Peru. Some lines are aligned to places where bright stars rose at that time, or where the Sun rose at particular times of the year. There are also many figures of animals. The figures are so large that it is easiest to see the patterns from the air.

3) Why was a knowledge of the stars so important to Polynesians?

Answer: The Polynesian people live on a group of widely separated islands in the South Pacific. Knowledge of the stars allowed navigators to determine their latitude and direction, both essential for traveling the large distances from island to island.

4) Describe how Eratosthenes first measured the size of Earth over 2,000 years ago.

Answer: Eratosthenes used measurements of the angle of the Sun in the sky at noon on the summer solstice in two places in Egypt. It was directly overhead in Syene and cast no shadows. In Alexandria, however, there was a slight shadow, indicating that the Sun was 7 degrees away from overhead. Eratosthenes concluded that Alexandria lies at a latitude 7 degrees north of Syene. The circumference of Earth is then the distance between Syene and Alexandria divided by the fraction of the circle ($7/360$) that the two cities span.

5) Describe the Ptolemaic model of the solar system. How did Ptolemy account for the apparent retrograde motion of the planets?

Answer: Although Ptolemy's model was an Earth-centered model of the solar system, it was sufficiently accurate to remain in use for 1,500 years. His model used the ancient idea that all motions in the heavens must be perfect circles. Therefore, the planets moved on circles that orbited on larger circles around Earth. This "circle upon circle" motion accounted for the apparent retrograde motion of the planets. Ptolemy carefully selected sizes for the circles to reproduce the motions seen in the sky. He also placed Earth slightly off-center to improve model predictions even more.

6) Describe one major accomplishment for each of the following people: Copernicus, Tycho Brahe, Kepler, Galileo, Newton.

Answer: Many possible answers: e.g., Copernicus: Sun-centered system; Tycho Brahe: collected key data for Kepler's discoveries; Kepler: laws of planetary motion; Galileo: overturning Aristotelian physics; Newton: laws of motion and gravity.

7) State Kepler's three laws of planetary motion.

Answer:

1. The orbit of each planet is an ellipse with the Sun at one focus.
2. As a planet moves around its orbit, it sweeps out equal areas in equal times.
3. A planet's period squared is equal to its semimajor axis cubed.

8) Summarize in your own words, the three "hallmarks" of science?

Answer: See Figure 3.24 in the textbook. As an example:

1. The quest to explain an observation by building on our knowledge of other aspects of nature
2. The creation and testing of models that explain observations as simply as possible
3. Models make testable predictions and are modified or abandoned if the predictions do not agree with observations

9) What is *pseudoscience*?

Answer: Pseudoscience is the explanation of events through models that purport to be scientific but which, in practice, do not contain the hallmarks of science. For example, predictions may be made but models are not adjusted if the predictions fail to match the observations.

10) Describe what a *scientific* test of astrology would involve.

Answer: First of all, science can only test the types of astrology that claim to be able to make predictions about future events or about characteristics of a person's personality and life. A scientific test of astrology requires evaluating many horoscopes and comparing their accuracy to what would be expected by pure chance. Therefore, one would have to evaluate how often a predicted event would likely occur naturally. Only if the astrologer could substantially beat the odds of predicting this event could one safely say that the astrologer could predict the future, at least concerning this particular event.

11) *Process of Science*: Give a scientific explanation of the success of the central African rainfall-prediction technique of observing the waxing crescent Moon. Can the Moon cause a change in rainfall? Or vice versa?

Answer: The Moon's orientation varies seasonally, and so does the weather, so the orientation and the weather are correlated, but one does not cause the other.

12) *Process of Science*: Why is it not science to start with the answer to a question and look for evidence to support it?

Answer: The process of science involves asking a question and then forming testable hypotheses in order to gather evidence either to support or to refute it. So-called "cherry picking" of evidence to support an idea and ignoring evidence that may refute it does not advance knowledge and is not the scientific method.

3.4 Mastering Astronomy Reading Quiz

1) What practical value did astronomy offer to ancient civilizations?

- A) It helped them keep track of time and seasons, and it was used by some cultures for navigation.
- B) It allowed them to predict eclipses with great accuracy.
- C) It helped them understand our cosmic origins.
- D) It helped them find uses for ancient structures like Stonehenge.

Answer: A

2) Scientific thinking is

- A) based on everyday ideas of observation and trial-and-error experiments.
- B) completely different from any other type of thinking.
- C) a difficult process that only a handful of people can do well.
- D) an ancient mode of thinking first invented in Egypt.

Answer: A

3) The names of the seven days of the week are based on

- A) the names of the seven planets closest to the Sun.
- B) the seven most prominent constellations in the summer sky.
- C) the names of prophets in the Bible.
- D) the seven naked-eye objects that appear to move among the constellations.

Answer: D

4) The *Metonic cycle* is

- A) used to keep lunar calendars approximately synchronized with solar calendars.
- B) used to predict the future orientation of the Earth's axis in space.
- C) the ancient Greek name for the cycle of lunar phases that repeats every 29 1/2 days.
- D) the 18-year, 11-day period over which the pattern of eclipses repeats.

Answer: A

- 5) Ptolemy was important in the history of astronomy because he
- A) developed a model of the solar system that made sufficiently accurate predictions of planetary positions to remain in use for many centuries.
 - B) developed the first scientific model of the universe.
 - C) was the first to create a model of the solar system that placed the Sun rather than the Earth at the center.
 - D) was the first to believe that all orbits are perfect circles.

Answer: A

- 6) The ancient Greeks get a lot of attention for their contributions to science because
- A) they were the first people known to try to explain nature with models based on reason and mathematics, without resort to the supernatural.
 - B) the books of every other culture were lost in the destruction of the library of Alexandria.
 - C) they were the first people to realize that Earth is a planet orbiting the Sun.
 - D) they were the only ancient culture that kept written records of their astronomical observations.

Answer: A

- 7) What do we mean by a *geocentric* model of the universe?

- A) It is a model designed to explain what we see in the sky while having the Earth located in the center of the universe.
- B) It is a model designed to explain what we see in the sky while having the Earth orbit the Sun.
- C) It is the name given to sphere-shaped models that show all the constellations as they appear in our sky on the celestial sphere.
- D) It is a model of the Milky Way Galaxy that has our solar system located at its center.

Answer: A

- 8) What was the *Ptolemaic* model?

- A) an Earth-centered model of planetary motion published by Ptolemy
- B) the Earth-centered model of the cosmos in which the Earth was surrounded by seven perfect spheres, one each for the Sun, Moon, Mercury, Venus, Mars, Jupiter, and Saturn
- C) the first scientific model to successfully predict solar and lunar eclipses
- D) a Sun-centered model of planetary motion published by Ptolemy

Answer: A

- 9) The great contribution of Nicholas Copernicus was to

- A) create a detailed model of our solar system with the Sun rather than Earth at the center.
- B) prove that the Earth is not the center of the universe.
- C) discover the laws of planetary motion.
- D) discover the law of gravity.

Answer: A

- 10) The great contribution of Tycho Brahe was to
- A) observe planetary positions with sufficient accuracy that later enabled Kepler to discover the laws of planetary motion.
 - B) discover four moons orbiting Jupiter, thereby lending strong support to the idea that the Earth is not the center of the universe.
 - C) offer the first detailed model of a Sun-centered solar system, thereby beginning the process of overturning the Earth-centered model of the Greeks.
 - D) discover that planets orbit the Sun in elliptical orbits with varying speed.

Answer: A

- 11) Which of the following was *not* observed by Galileo?

- A) stellar parallax
- B) mountains and valleys on the Moon
- C) four moons orbiting Jupiter
- D) phases of Venus

Answer: A

- 12) Which of the following statements about an ellipse is *not* true?

- A) The focus of an ellipse is always located precisely at the center of the ellipse.
- B) A circle is considered to be a special type of ellipse.
- C) The semimajor axis of an ellipse is half the length of the longest line that you can draw across an ellipse.
- D) An ellipse with a large eccentricity looks much more elongated (stretched out) than an ellipse with a small eccentricity.

Answer: A

- 13) Which of the following is *not* one of, nor a direct consequence of, Kepler's Laws?

- A) The force of attraction between any two objects decreases with the square of the distance between their centers.
- B) As a planet moves around its orbit, it sweeps out equal areas in equal times.
- C) The orbit of each planet about the Sun is an ellipse with the Sun at one focus.
- D) More distant planets orbit the Sun at slower speeds.
- E) A planet or comet in a noncircular orbit travels faster when it is nearer to the Sun and slower when it is farther from the Sun.

Answer: A

- 14) Scientific models are used to

- A) present the scale of the solar system to the general public.
- B) make specific predictions that can be tested through observations or experiments.
- C) make miniature representations of the universe.
- D) prove that past paradigms no longer hold true.

Answer: B

15) In science, a broad idea that has been repeatedly verified so as to give scientists great confidence that it represents reality is called

- A) a paradigm.
- B) a hypothesis.
- C) Ptolemaic model.
- D) a theory.

Answer: D

16) Which of the following best describes how modern astronomers view astrology?

- A) Astrology played an important part in the development of astronomy in ancient times, but it is not a science by modern standards.
- B) Astrology is a synonym for astronomy.
- C) Astrology was a great idea until it was disproved by the work of Copernicus, Tycho, Kepler, and Galileo.
- D) Astrology is new age mumbo-jumbo that was a waste of time when it was invented thousands of years ago and remains a waste of time today.

Answer: A

3.5 Mastering Astronomy Concept Quiz

1) Suppose the planet Uranus were much brighter in the sky, so that it was as easily visible to the naked eye as Jupiter or Saturn. Which one of the following statements would *most likely* be true in that case?

- A) A week would have eight days instead of seven despite the year length remaining constant.
- B) Its brightness would make it possible to read by starlight at night.
- C) Its gravity would cause the tides to be much higher than they actually are.
- D) The discovery that the Earth is a planet going around the Sun would have come hundreds of years earlier.
- E) Its slow motion through the sky would have led it to be named after the Goddess of Procrastination.

Answer: A

2) How does a 12-month lunar calendar differ from our 12-month solar calendar?

- A) It has about 11 fewer days.
- B) It does not have seasons.
- C) Its new year always occurs in February instead of on January 1.
- D) It uses a 23-hour rather than a 24-hour day.

Answer: A

3) Which of the following best describes a set of conditions under which archaeoastronomers would conclude that an ancient structure was used for astronomical purposes?

A) The structure has holes in the ceiling that allow viewing the passage of constellations that figure prominently in the culture's folklore, and many other structures built by the same culture have ceiling holes placed in the same way.

B) They find that, looking out from the center of the building, there are two windows that align with the rise and set points of two bright stars.

C) The structure has 29 straight lines pointing out from a center, just like there are 29 days in the lunar cycle.

D) The structure has the same dome shape as modern astronomical observatories.

Answer: A

4) How did the Ptolemaic model explain the apparent retrograde motion of the planets?

A) The planets moved along small circles that moved on larger circles around Earth.

B) The planets sometimes stopped moving and then reversed to move backward along their circular orbits.

C) The model showed that apparent retrograde motion occurs as Earth passes by another planet in its orbit of the Sun.

D) The planets resided on giant spheres that sometimes turned clockwise and sometimes turned counterclockwise.

Answer: A

5) When Copernicus first created his Sun-centered model of the universe, it did not lead to substantially better predictions of planetary positions than the Ptolemaic model. Why not?

A) Copernicus used perfect circles for the orbits of the planets, though they are actually ellipses.

B) Copernicus placed the planets in the wrong order going outward from the Sun.

C) Copernicus misjudged the distances between the planets.

D) Copernicus placed the Sun at the center, but did not realize that the Moon orbits Earth.

Answer: A

6) Earth is farthest from the Sun in July and closest to the Sun in January. During which Northern Hemisphere season is Earth moving fastest in its orbit?

A) Spring

B) Summer

C) Fall

D) Winter

Answer: D

7) According to Kepler's third law ($p^2 = a^3$), how does a planet's mass affect its orbit around the Sun?

A) A planet's mass has no effect on its orbit around the Sun.

B) More massive planets orbit the Sun at higher average speed.

C) More massive planets must have more circular orbits.

D) A more massive planet must have a larger semimajor axis.

Answer: A

8) All the following statements are true. Which one follows directly from Kepler's third law ($p^2 = a^3$)?

- A) Venus orbits the Sun at a slower average speed than Mercury.
- B) Venus is more massive than Mercury.
- C) Venus takes longer to rotate than it does to orbit the Sun.
- D) Venus has a thicker atmosphere than Mercury.

Answer: A

9) Suppose a comet orbits the Sun on a highly eccentric orbit with an average (semimajor axis) distance of 1 AU. How long does it take to complete each orbit, and how do we know?

- A) One year, which we know from Kepler's third law.
- B) It depends on the eccentricity of the orbit, as described by Kepler's second law.
- C) It depends on the eccentricity of the orbit, as described by Kepler's first law.
- D) Each orbit should take about 2 years, because the eccentricity is so large.

Answer: A

10) Galileo challenged the idea that objects in the heavens were perfect by

- A) showing that heavy objects fall at the same rate as lighter objects.
- B) observing sunspots on the Sun and mountains on the Moon.
- C) proving Kepler's laws were correct.
- D) inventing the telescope.

Answer: B

11) Galileo observed all of the following. Which observation offered direct proof of a planet orbiting the Sun?

- A) phases of Venus
- B) four moons of Jupiter
- C) patterns of shadow and sunlight near the dividing line between the light and dark portions of the Moon's face
- D) The Milky Way is composed of many individual stars.

Answer: A

12) Which of the following is *not* consistent with the major hallmarks of science?

- A) Science consists of proven theories that are understood to be true explanations of reality.
- B) Scientific explanations should be based solely on natural causes.
- C) Science progresses through the creation and testing of models that explain observation as simply as possible.
- D) A scientific model must make testable predictions.

Answer: A

13) Which of the following is *not* part of a good scientific theory?

- A) A scientific theory cannot be accepted until it has been proven true beyond all doubt.
- B) A scientific theory must make testable predictions that, if found to be incorrect, could lead to its own modification or demise.
- C) A scientific theory must explain a wide variety of phenomena observed in the natural world.
- D) A scientific theory should be based on natural processes and should not invoke the supernatural or divine.

Answer: A

14) Only one of the statements below uses the term *theory* in its correct, scientific sense. Which one?

- A) Einstein's theory of relativity has been tested and verified thousands of times.
- B) Evolution is only a theory, so there's no reason to think it really happened.
- C) I have a new theory about the cause of earthquakes, and I plan to start testing it soon.
- D) I wrote a theory that is 152 pages long.

Answer: A

15) The astrology practiced by those who cast predictive horoscopes can be tested by

- A) comparing how often the predictions come true to what would be expected by pure chance.
- B) asking astrologers if it works.
- C) polling people to find out what percentage believe their horoscopes to be accurate.
- D) counting how many times the predictions come true.

Answer: A