# Test Bank for Discovering the Essential Universe 6th Edition by Comins ISBN 1464181705 9781464181702



Import Settings:
Base Settings: Brownstone Default
Information Field: Section
Highest Answer Letter: D
Multiple Keywords in Same Paragraph: No

Chapter: Chapter 2: Gravitation and the Waltz of the Planets

Multiple Choice

So far as we know, the first person who claimed that natural phenomena could be described by mathematics was:
A) Copernicus.
B) Pythagoras.
C) Aristotle.
D) Ptolemy.

Ans: B
Section: Chapter 2, Introduction

The groundwork for modern science was laid by the first investigators who used mathematics to describe natural phenomena. These investigators were:

A) the Babylonians, about 1800 B.C.
B) the Ionians, about 600 B.C.
C) the Pythagoreans, about 550 B.C.
D) Ptolemy and his associates, about 150 A.D.

Ans: C
Section: Chapter 2, Introduction

The ancient Greek thinker Pythagoras held the view that:
A) triangles do not exist.
B) natural phenomena are wonderful to watch but cannot be described by mathematics.
C) the Sun is at the center of the planetary system.
D) natural phenomena can be described mathematically.

Ans: D
Section: Chapter 2, Introduction

What distinguished the Pythagoreans from the natural philosophers who came before them?
A) They had uncovered the scientific writings of the Babylonians.
B) They invented a crude telescope.
C) They attempted to make mathematical models of physical phenomena.
D) Through trade routes, they had been exposed to the philosophy of the ancient orient.

Ans: C
Section: Chapter 2, Introduction

Ancient Greek philosophers put forth the idea that: A) the universe is governed by regular laws.
B) the Sun is the center of the solar system.
C) Earth is only one of hundreds of planets scattered throughout the Galaxy.
D) gravitation keeps the planets in their orbits.

Ans: A
Section: Chapter 2, Introduction

A major theme of ancient Greek philosophy was that stars and planets in the sky: A) followed patterns that could be described logically.
B) could be controlled by the thoughts and actions of humans.
C) were at the mercy of gods and spirits, and the behavior of these objects depended on their whims.
D) behaved chaotically, and their future behavior was totally unpredictable.

Ans: A
Section: Chapter 2, Introduction

The first person to realize that the force holding us onto Earth is the same force that holds the solar system together was apparently:
A) Plato. B)
Aristotle. C)
Newton. D)
Einstein.

Ans: C
Section: Chapter 2, Introduction

The intellectual foundation of science is:
A) observation, faith, and acceptance.
B) rejection of all observations that disagree with theory.
C) logical derivation entirely from fundamental principles.
D) observation, logic, and skepticism.

Ans: D
Section: 2-1

A scientist observes a new phenomenon that disagrees with his explanation or hypothesis. Following the scientific method, he should:
A) discard the observation as erroneous.
B) modify his hypothesis.
C) wait until someone develops an adequate explanation before announcing his observation.
D) reject those observations that do not agree with the theory.

Ans: B
Section: 2-1

In science, if new and reliable observations disagree with a well-established theory, then the:
A) observations should be classified for future reference and the theory retained as the

best explanation of the phenomenon.
observations must be discarded.
theory must be discarded.
theory must be modified to account for the observations, and if this is not possible, then the theory must be discarded.

Ans: D
Section: 2-1

In science, if new and reliable observations disagree with a particular theory, then the:
A) observations must be discarded.
B) theory must be modified.
C) observations and the theory should both be retained.
D) theory must be discarded.

Ans: B
Section: 2-1

The scientific method is a major force in science, and theories describing physical phenomena have been developed with the aim of ensuring that:
A) they agree with what we find in experiments and observations.
B) results from experiments can be adjusted to agree with carefully constructed theoretical ideals.
C) they agree with the wisdom of the ancients.
D) they are so good and our faith in them is so strong that we never need to test them against observations.

Ans: A
Section: 2-1

Which one of the following is NOT part of the scientific method?
A) Make an observation or do an experiment.
B) Analyze results.
C) Determine consistency with recognized authorities.
D) Choose the simplest existing theory.

Ans: C
Section: 2-1

Which one of the following is NOT part of the scientific method?
A) Propose a new experiment.
B) Take a formal vote at a recognized international scientific conference.
C) Modify existing theory.
D) Make predictions.

Ans: B
Section: 2-1

In following the principles of the scientific method, a theory proposed to explain a given phenomenon must:
A) agree with and build on previous theories but need not explain all observations because some of the observations may be erroneous.
B) predict new and different experiments that will extend the scope of the theoretical understanding but need not explain all the previous observations because no theory is expected to explain everything completely.
C) explain all previous reliable observations in a consistent manner but need not suggest new tests for the theory because a theory should be complete in itself.
D) explain all known reliable observations and predict new experiments and observations.

Ans: D
Section: 2-1

According to the scientific method, a hypothesis that is proposed to explain a particular physical phenomenon is considered to be wrong if:
A) leading scientists in the world believe that it is wrong.
B) it disagrees with the accepted theory at the time of the proposal.
C) it appears to defy logic and logical reasoning.
D) it is in conflict with the results of just one reliable and repeatable observation.

Ans: D
Section: 2-1

The development of the scientific theory related to the Higgs boson was unusual in that:

A) it began with observations made a century ago.

B) it began with theoretical calculations rather than observations.

C) the observations that began the investigation disproved the currently accepted model, thus leaving theorists with no structure to build upon.

D) the original theory was an outgrowth of an entirely unrelated area of anthropology.

Ans: B

Section: 2-1

In applying the scientific method to the study of our natural surroundings, scientists are:

A) discovering by observation the absolute truth about limited areas of science and are therefore slowly building up the correct view of the universe.

B) slowly amassing a vast bank of observations of nature that at some time in the future will be assembled into the correct description of the universe.

C) formulating hypotheses or models that describe the present observations of nature and that predict possible further tests for these models.

D) developing a theoretical view of the universe that incorporates all previous ideas and beliefs as part of an overall philosophy.

Ans: C

Section: 2-1

19. A vital part of the scientific hypothesis is that it:

is possible, in principle, to disprove it by observation.

is possible, in principle, to disprove it by logical argument.

must be mathematically simple.

must be mathematically complex.

Ans: A

Section: 2-1

Which of the following is a critical component of the scientific method? A) belief that a theory accepted by leading scientists is correct
B) rejection of new scientific results when they disagree with the presently accepted theory
C) automatic rejection of a theory when new results disagree with its predictions
D) testing of predictions from a scientific theory or theoretical model

Ans: D
Section: 2-1

A scientific theory is accepted as the BEST description of a certain phenomenon if it:
A) can be independently and repeatedly checked by observation.
B) has been developed by a scientist with a solid reputation, such as Albert Einstein or Sir Isaac Newton.
C) has obtained the stamp of approval of an internationally renowned scientific body, such as the Royal Society of London or the International Astronomical Union.
D) accounts for a full range of historical observations, even though recent observations cast doubt on it.

Ans: A
Section: 2-1

22. What is the ultimate test for a scientific theory or idea?
A world body such as the United Nations must decree that the theory is correct.
The theory must be accepted by the vast majority of the population of Earth.
The theory must make predictions that are verifiable by observation or measurement.
The theory must be accepted by the vast majority of the scientific community.

Ans: C
Section: 2-1

Which of the following statements MOST closely expresses the principle of "Occam's razor" as it applies to theoretical explanations of physical phenomena?
A) The theory with the longest history is the most likely explanation.
B) The theory requiring the least number of assumptions is the most likely explanation.
C) The newest theory is most likely to be the correct one.
D) The theory requiring the largest number of assumptions is the most likely explanation.

Ans: B
Section: 2-1

24. The concept called "Occam's razor" tells us that:
the theory that is applicable to the greatest range of phenomena is more likely to be correct.
when two theories describe the same phenomena equally accurately, the theory with the greater complexity is more likely to be correct.
when two theories describe the same phenomena equally accurately, the simpler theory is more likely to be correct.
the theory that describes phenomena more accurately is more likely to be correct.

Ans: C
Section: 2-1

When choosing among scientific explanations for a phenomenon, all else being equal, the simpler theory is more likely correct. This philosophy is associated with:
A) Pythagoras.
B) Aristotle.
C) Occam.
D) Kepler.

Ans: C
Section: 2-1

What is the name for a theory that describes the overall structure of the universe?
A) field theory
B) astrology
C) cosmology
D) astronomy

Ans: C
Section: 2-2

Not counting Earth, the number of planets known to the ancients was: A) four.
B) five.
C) seven.
D) eight.

Ans: B
Section: 2-2

28. In the ancient Greek era, it was almost universally believed that:
the pole star represented the center of the universe about which Earth and all other objects revolved.
the Milky Way represented the observable universe, and its center was the center of the universe.
the Sun was at the center of the universe.
Earth was at the center of the universe.

Ans: D
Section: 2-2

As far as we know, the first person to propose a Sun-centered model of the solar system was
A) Plato.
B) Aristarchus of Samos.
C) Ptolemy.
D) Copernicus.

Ans: B
Section: 2-2

The ancient Greek thinker whose model of the universe came to dominate the medieval world was:
A) Archimedes.
B) Alexander.
C) Ptolemy.
D) Zorba.

Ans: C
Section: 2-2

The center, or fixed point, of the Greek model of the universe was:
A) the center of the Galaxy.
B) a point midway between Earth and the Sun.
C) the Sun's center.
D) close to Earth's center.

Ans: D
Section: 2-2

The word *planet* is derived from a Greek term meaning:
A) bright nighttime object.
B) astrological sign.
C) wanderer.
D) non-twinkling star.

Ans: C
Section: 2-2

The planets that were known before the telescope was invented
are: A) Mercury, Venus, Mars, Jupiter, and Neptune.
B) Saturn, Venus, Mars, Mercury, and Jupiter.
C) Jupiter, Mercury, Mars, Uranus, and Venus.
D) Venus, Jupiter, Saturn, Mars, and Pluto.

Ans: B
Section: 2-2

Planets move past the background stars as seen by someone on Earth. What is the normal direction of this motion?
A) east to west because of the rotation of Earth
B) east to west because of the motion of the planet along its orbit
C) west to east because of the motion of Earth along its orbit D)
west to east because of the motion of the planet along its orbit

Ans: D
Section: 2-2

The motions of the planets against the background stars in our sky can best be described as:
A) regular patterns with general eastward motion interrupted by periods of westward motion.
B) regular and uniform eastward motion.
C) general eastward motion but with occasional stationary periods with no motion at all.
D) regular patterns with general westward motion interrupted by periods of eastward motion.

Ans: A
Section: 2-2

When observing planetary motions from Earth, the term *direct motion* refers to the: A) slow westward motion of the planet from night to night compared with the background stars.
B) apparent westward motion of the planet (and the Sun, the Moon, and stars) across the sky due to the rotation of Earth.
C) motion of the planet directly toward or away from Earth in certain parts of the planet's orbit.
D) slow eastward motion of the planet from night to night compared with the background stars.

Ans: D
Section: 2-2

An apparent eastward motion of a planet from night to night compared with the background stars (as viewed from Earth) is referred to as:
A) rising (if in the east) or setting (if in the west).
B) direct motion.
C) precession.
D) retrograde motion.

Ans: B

Section: 2-2

An apparent westward motion of a planet from night to night compared with the background stars (as viewed from Earth) is referred to as:
A) retrograde motion.
B) precession.
C) rising (if in the east) or setting (if in the west).
D) direct motion.

Ans: A
Section: 2-2

When observing planetary motions from Earth, the term *retrograde motion* refers to the:
A) apparent westward motion of the planet (and the Sun, the Moon, and stars) across the sky due to the rotation of Earth.
B) motion of the planet away from Earth during part of its orbit.
C) slow eastward motion of the planet from night to night compared with the background stars.
D) slow westward motion of the planet from night to night compared with the background stars.

Ans: D
Section: 2-2

40. The term *retrograde motion* for a planet refers to the:
temporary reversal of the planet's normal east-to-west motion past the background stars as seen from Earth.
apparent motion of a planet's moon in the direction opposite the motion of the planet itself during half of each orbit of the moon around the planet.
temporary reversal of a planet's direction of spin about its axis of rotation.
temporary reversal of the planet's normal west-to-east motion past the background stars as seen from Earth.

Ans: D
Section: 2-2

The direction of retrograde motion for a planet as seen by an observer on Earth is:
A) west to east relative to the background stars.
B) east to west relative to the background stars.
C) east to west relative to objects on the person's horizon.
D) west to east relative to objects on the person's horizon.

Ans: B
Section: 2-2

42. Retrograde motion of a planet is:
westward motion against the star background.
westward motion with respect to the foreground on Earth.
eastward motion with respect to the Moon.
eastward motion against the star background.

Ans: A
Section: 2-2

Retrograde motion of a planet against the background stars is always:
A) apparent motion of the planet away from Earth.
B) movement northward, away from the ecliptic plane.
C) movement from west to east.
D) movement from east to west.

Ans: D
Section: 2-2

Retrograde motion of a planet refers to which motion, when viewed from Earth? A) setting of the planet in the west to any observer caused by Earth's rotation
B) eastward apparent motion with respect to the stars
C) southward motion of the planet as it moves away from the northern sky
D) westward apparent motion with respect to the stars

Ans: D

Section: 2-2

Which of the following objects does NOT experience retrograde motion when viewed from Earth?
A) Mercury
B) Mars
C) the Moon
D) Jupiter

Ans: C
Section: 2-2

Which of the following objects does NOT experience retrograde motion when viewed from Earth?
A) Mars
B) Venus
C) the Sun
D) Pluto

Ans: C
Section: 2-2

When the planet Mars is moving in a retrograde direction, its motion against the background stars is seen to be:
A) stationary, with no motion against the stars.
B) exactly perpendicular to the equator.
C) eastward.
D) westward.

Ans: D
Section: 2-2

Retrograde motion causes the planets to:
A) rise in the west and set in the east.

move westward with respect to the stars.
move at the same rate as the stars.
move eastward with respect to the stars.

Ans: B
Section: 2-2

How long does a typical retrograde loop for Mars take? A) two days
B) one week
C) six months
D) six years

Ans: C
Section: 2-2

In the path of Mars against the background stars shown in Figure 2-2 in Comins, *Discovering the Essential Universe*, 6th ed., the planet appears from Earth to move in a loop, moving westward for a period of time. What is the angle between the Earth-Sun line and the Earth-Mars line when the planet is halfway through the retrograde motion, on about February 1?
A) 180°
B) It can be any angle.
C) 0°
D) 90°

Ans: A
Section: 2-2

Retrograde motion of a planet when viewed from Earth is caused by the fact that: A) the planet's orbit is inclined at an angle to Earth's orbit.
B) the planet's orbit is elliptical.
C) the Sun is moving.
D) the Earth is moving.

Ans: D
Section: 2-2

The initial reason that the geocentric model for the solar system began to be discarded after the fifteenth century A.D. was that:
A) observations by spacecraft proved that all planets orbit the Sun.
B) the invention of the telescope provided observations that were in better agreement with a heliocentric model.
C) Isaac Newton was able to derive all planetary motion from one universal law of gravity.
D) the heliocentric model is conceptually simpler.

Ans: D
Section: 2-2

When viewed from Earth, the celestial sphere (the background of stars) moves east to west on a daily basis. This motion is caused by the:
A) rotation of Earth on its axis.
B) revolution of Earth around the Sun. C)
motion of the Sun through the Galaxy.
D) motion of the stars around the galactic center.

Ans: A
Section: 2-2

From Earth, we observe occasional retrograde motion in the motion of:
A) only the inner planets—Mercury and Venus.
B) only the outer planets—Mars and beyond.
C) all the planets.
D) all the planets and the Moon.

Ans: C
Section: 2-2

If you were observing Earth's motion from another planet, would you observe occasional retrograde motion?
A) no

yes, but only from the inner planets—Mercury and Venus
yes, but only from the outer planets—Mars and beyond
yes, from any of the planets

Ans: D
Section: 2-2

On a larger scale, the solar system itself orbits the:
A) supergiant star Rigel.
B) Large Magellanic Cloud.
C) center of the Milky way Galaxy.
D) center of the universe.

Ans: C
Section: 2-2

Ptolemy's nationality was:
A) Polish.
B) Greek. C)
Italian. D)
Egyptian.

Ans: B
Section: Discovery 2-1: Earth-centered Universe, Chapter 2

The Greek mathematician Ptolemy devised a:
A) sundial.
B) geocentric model for the solar system.
C) heliocentric model for the solar system.
D) method to measure Earth's radius.

Ans: B
Section: Discovery 2-1: Earth-centered Universe, Chapter 2

59. Ptolemy's model for the solar system was:

Earth-centered, with the Sun, the Moon, and the planets moving in ellipses in the sky.
Sun-centered, with elliptical planetary orbits.
Sun-centered, with the planets moving in circles around it.
Earth-centered, with planetary orbits composed of deferents and epicycles.

Ans: D
Section: Discovery 2-1: Earth-centered Universe, Chapter 2

60. A major contribution of Ptolemy to the development of astronomy was:
origination of the idea of a geocentric (Earth-centered) cosmology, which was later developed by Aristarchus.
derivation of a model for the solar system in which the planets move around the Sun in circular orbits.
derivation of the model for the solar system in which the planets move around Earth in elliptical orbits, moving fastest when closest to Earth.
derivation of a model for the solar system in which the planets moved in epicycles and the epicycles orbited Earth.

Ans: D
Section: Discovery 2-1: Earth-centered Universe, Chapter 2

In the geocentric model of the solar system developed by Ptolemy, the planets move:
A) with varying speeds in elliptical orbits around Earth.
B) at constant speeds in circular orbits around Earth.
C) in circular epicycles around the Sun while the Sun moves in a circular orbit around Earth.
D) in circular epicycles while the centers of the epicycles move in circular orbits around Earth.

Ans: D
Section: Discovery 2-1: Earth-centered Universe, Chapter 2

62. The epicycle, in the Greek planetary model, is the:
circle centered on Earth about which the center of the smaller circular motion moves.
off-center point in the planetary system occupied by Earth.
focus of the ellipse that is the orbit of the planet around Earth.
small circle through which the planet moves as the center of this circle orbits Earth.

Ans: D

Section: Discovery 2-1: Earth-centered Universe, Chapter 2

In the geocentric model for the solar system developed by Ptolemy, to what does the word *epicycle* refer?

A) small circle about which a planet moves while the center of this circle moves around Earth

B) large circle (orbit) that carries the planet around Earth while the planet itself is moving in a smaller circle

C) complete cycle of planetary motions after which the motions repeat themselves (almost) exactly

D) length of time from when the planet is farthest from Earth to the next time it is farthest from Earth

Ans: A

Section: Discovery 2-1: Earth-centered Universe, Chapter 2

In Ptolemy's geocentric theory of the solar system, what name is given to the small circle around which the planet moves while the center of this circle orbits Earth?

A) the epicycle

B) the ecliptic

C) the deferent

D) the celestial equator

Ans: A

Section: Discovery 2-1: Earth-centered Universe, Chapter 2

In Ptolemy's description of the solar system, the deferent is

a(n): A) elliptical path along which a planet moves around the Sun.

B) circular path (around the Sun) along which the center of a planet's epicycle moves. C) circular path (around a point near Earth) along which the center of a planet's epicycle moves.

D) circular path along which a planet moves while the center of the path moves in a circle around Earth.

Ans: C

Section: Discovery 2-1: Earth-centered Universe, Chapter 2

66. In the Greek planetary model, the deferent is the:
part of the planet's orbit when it appears to move "backward" (i.e., westward) in the sky.
off-center point in the planetary system occupied by Earth.
small circle about which the planet moves as the center of the circle orbits Earth.
circle about which each planet's epicycle center moves.

Ans: D

Section: Discovery 2-1: Earth-centered Universe, Chapter 2

In the geocentric model for the solar system developed by Ptolemy, to what does the word *deferent* refer?
A) distance of the center of the epicycle from the center of Earth
B) small circle about which a planet moves while the center of the circle moves around Earth
C) distance of offset between the center of Earth and the center of a planet's orbit
D) large circle (orbit) that carries the planet around Earth while the planet itself is moving in a smaller circle

Ans: D

Section: Discovery 2-1: Earth-centered Universe, Chapter 2

In Ptolemy's geocentric theory of the solar system, what name is given to the large circle (orbit) that carries the planet around Earth?
A) the deferent
B) the celestial equator
C) the ecliptic
D) the epicycle

Ans: A

Section: Discovery 2-1: Earth-centered Universe, Chapter 2

69. In the Ptolemaic model of the solar system, the deferent was centered at:

Earth.
a point near Earth.
the Sun.
the barycenter of the Earth-Moon system.

Ans: B
Section: Discovery 2-1: Earth-centered Universe, Chapter 2

In the Ptolemaic model of the solar system, the Sun's orbit, like the deferents of the planets, was not centered exactly on Earth. This could help explain each of the following features associated with the Sun, EXCEPT ONE. Which is the exception?
A) Its size appears to change slightly during the year.
B) Its speed across the sky appears to change slightly during the year.
C) Its brightness appears to change slightly during the year.
D) It is responsible for the seasons on Earth.

Ans: D
Section: Discovery 2-1: Earth-centered Universe, Chapter 2

71. In the geocentric universe, when is the planet closest to Earth?
There is no specific time in the orbit when the planet is closest to Earth.
during retrograde motion, westward
during direct motion, eastward
when the planet is crossing the deferent

Ans: B
Section: Discovery 2-1: Earth-centered Universe, Chapter 2

According to the Ptolemaic model of the solar system, during retrograde motion a planet would be:
A) at varying distances from Earth, sometimes closer and sometimes farther away than the average distance.
B) farther away from Earth than average.
C) closer to Earth than average.
D) always at the same distance from Earth because the planet orbits Earth in a circle in this model.

Ans: C

Section: Discovery 2-1: Earth-centered Universe, Chapter 2

The purpose of describing planetary orbits in terms of epicycles and deferents was to account for the:
A) fact that a planet's speed in its orbit is fastest when it is closest to the Sun.
B) pattern of alternating conjunctions and oppositions.
C) pattern of alternating direct and retrograde motion.
D) general motion of all objects toward the west in the sky each day.

Ans: C
Section: Discovery 2-1: Earth-centered Universe, Chapter 2

The retrograde portion of a planet's motion has what duration? A) a few days to a few weeks
B) a few weeks to a few months
C) a few days to a few months
D) a few weeks to a few years

Ans: B
Section: Discovery 2-1: Earth-centered Universe, Chapter 2

Ptolemy's system of planetary motions, as described in the *Almagest*, was based on: A) magnetism.
B) gravitation.
C) electrical forces.
D) no underlying physical theory.

Ans: D
Section: Discovery 2-1: Earth-centered Universe, Chapter 2

If you were an astronomer in the closing days of the Roman Empire (say, 400 A.D.), your main reference book would probably have been:
A) Ptolemy's *Almagest*.
B) Plato's *Republic*.
C) Copernicus's *De Revolutionibus*.

Galileo's *Dialogues Concerning the Two Chief World Systems*.

Ans: A
Section: Discovery 2-1: Earth-centered Universe, Chapter 2

After a thousand years, Ptolemy's system of planetary motion gave readings that were less accurate than the readings it gave when it was first devised. One main reason for this was that:
A) measuring instruments had improved to the point where small prediction errors could be detected.
B) proper motions of the stars over a millennium had changed their positions.
C) precession had altered the seasonal positions of the planets and constellations.
D) the orbits of the planets have drifted slowly over time.

Ans: C
Section: Discovery 2-1: Earth-centered Universe, Chapter 2

Before the invention of the telescope, the known planets were:
A) Mercury, Venus, Mars, Jupiter, and Saturn.
B) Mercury, Venus, Mars, Jupiter, and Uranus.
C) Jupiter, Venus, Neptune, Mars, and Saturn.
D) Mars, Neptune, Jupiter, Mercury, and Venus.

Ans: A
Section: 2-3

79. Nicolaus Copernicus was the first person to:
develop a comprehensive model for a Sun-centered solar system.
use a telescope to observe the sky at night.
use ellipses to describe the orbits of the planets.
describe planetary orbits using the force of gravity.

Ans: A
Section: 2-3

The person who developed the first comprehensive model for a heliocentric cosmology was:
A) Kepler. B)
Ptolemy. C)
Aristarchus. D)
Copernicus.

Ans: D
Section: 2-3

81. Copernicus lived:
after Kepler but before Newton.
after Ptolemy but before Kepler.
after Kepler but before Ptolemy.
after Newton but before Kepler.

Ans: B
Section: 2-3

82. The Copernican system for planetary motions is:
Earth-centered, with the planets, the Sun, and the stars mounted on crystal spheres, pivoted to allow the correct motions around Earth.
Earth-centered, with the planets moving in epicycles around Earth.
Sun-centered, with the planets moving in elliptical orbits and the Sun at one focus of the ellipse.
Sun-centered, with the planets moving in perfect circles around the Sun.

Ans: D
Section: 2-3

The contribution of Copernicus to the development of astronomy was a mathematical model for a:
A) heliocentric cosmology in which the planets move in circular orbits.
B) solar system in which the planets move under the gravitational influence of the Sun.
C) heliocentric cosmology in which the planets move in elliptical orbits.
D) geocentric cosmology in which the planets move in circular epicycles.

Ans: A
Section: 2-3

Copernicus used the fact that Mars can sometimes be seen high in the sky at midnight to conclude that:
A) the Sun can come between Earth and Mars.
B) Earth can come between Mars and the Sun.
C) Mars and the Sun can never be on the same side of Earth at the same time.
D) Mars can come between Earth and the Sun.

Ans: B
Section: 2-3

Which of the following statements CORRECTLY describes why Copernicus decided that the orbits of Mercury and Venus are smaller than the orbit of Earth?
A) Both Mercury and Venus can sometimes be seen high in the sky at midnight.
B) Both Mercury and Venus show a complete cycle of phases, like the Moon. C)
Both Mercury and Venus stay fairly close to the Sun in the sky.
D) Both Mercury and Venus occasionally pass through conjunction with the Sun as seen from Earth.

Ans: C
Section: 2-3

Which of the following observations might you be able to make from Earth? A) Mercury and Venus passing each other, moving in opposite directions
B) Jupiter near Polaris, the North Star
C) Venus high in the sky at midnight
D) Mars, Saturn, and the Moon forming a large, equal-sided triangle

Ans: A
Section: 2-3

When Venus is at inferior conjunction, it is:
A) at its greatest distance from Earth.
B) traveling at its greatest speed.
C) at its greatest angle from the Sun as seen from Earth.
D) at its smallest distance from Earth.

Ans: D
Section: 2-3

88. A planet at inferior conjunction is always:
on the opposite side of the sky from the Sun as seen from Earth.
closer to Earth than the Sun is.
below Earth's horizon and therefore invisible.
farther away from Earth than the Sun is.

Ans: B
Section: 2-3

An inferior planet will be closest to Earth when it is at:
A) inferior conjunction.
B) greatest elongation.
C) opposition.
D) superior conjunction.

Ans: A
Section: 2-3

Which of the following planetary configurations or positions is IMPOSSIBLE for one of the outer planets?
A) opposition
B) conjunction
C) perihelion
D) inferior conjunction

Ans: D
Section: 2-3

Venus can pass in front of the Sun as seen from Earth when it is at: A) inferior conjunction.
B) superior conjunction.
C) opposition.
D) greatest elongation.

Ans: A
Section: 2-3

According to the heliocentric theory, which of the following objects can NEVER transit (pass in front of) the Sun as seen from Earth?
A) the Moon
B) Mercury
C) Venus D)
Mars

Ans: D
Section: 2-3

Which of the following objects could transit (pass in front of) the Sun as seen from Saturn?
A) Uranus
B) Neptune
C) Pluto D)
Jupiter

Ans: D
Section: 2-3

As seen by an observer on Saturn (or one of its moons), which of the following planets can NEVER pass through inferior conjunction?
A) Jupiter
B) Neptune
C) Venus

D)  Earth

Ans: B
Section:  2-3

When Mercury is at its farthest distance from Earth, it is at: A) opposition.
B) greatest elongation.
C) inferior conjunction.
D) superior conjunction.

Ans: D
Section:  2-3

An inferior planet is farthest from Earth when it is at:
A) superior conjunction.
B) opposition.
C) inferior conjunction.
D) greatest elongation.

Ans: A
Section:  2-3

When Venus is at superior conjunction, it is:
A) at its smallest distance from Earth.
B) at its greatest angle from the Sun as seen from Earth.
C) traveling at its greatest speed in its orbit.
D) at its greatest distance from Earth.

Ans: D
Section:  2-3

The BEST time(s) to see inferior planets from Earth is/are when these planets are at positions of:

opposition.
greatest elongation.
inferior conjunction.
superior conjunction.

Ans: B
Section: 2-3

Greatest elongation in a planetary orbit occurs when the angle from:
A) Earth to the planet and then to the Sun has its greatest possible value.
B) the Sun to Earth and then to the planet is 90°.
C) Earth to the Sun and then to the planet is 90°.
D) the Sun to the planet and then to Earth is 90°.

Ans: D
Section: 2-3

In what direction is Venus moving when it is at greatest elongation? A) directly toward or away from Earth
B) directly toward or away from the Sun
C) It is not possible to say because the direction is different from one greatest elongation to the next.
D) perpendicular to the line from Venus to Earth

Ans: A
Section: 2-3

At what position in its orbit does an inferior planet appear to be moving (for a day or two) more or less directly toward Earth? (See Figure 2-4 in Comins, *Discovering the Essential Universe*, 6th ed. Draw a diagram if it will help.)
A) inferior conjunction
B) superior conjunction
C) opposition
D) greatest eastern elongation

Ans: D
Section: 2-3

Where and when would Venus be seen from Earth when it is at greatest elongation? A) just before sunrise, in the west
B) at midnight, in the south C) just after sunset, in the east D) just after sunset, in the west

Ans: D
Section: 2-3

In which part of the sky does Venus appear at sunset when it is at greatest elongation?
A) due south
B) western
C) It is not visible because it is on the other side of the Sun.
D) eastern

Ans: B
Section: 2-3

The eastern elongation of Mercury's orbit: A) is always the same.
B) depends on both the positions of Earth and Mercury in their orbits.
C) is always smaller than the western elongation.
D) is always the same as the western elongation.

Ans: B
Section: 2-3

An inferior planet moves more or less directly toward Earth at greatest eastern elongation. What does this mean when you are watching the night-by-night motion of this planet against the background stars?
A) The planet appears to remain stationary for a few days.

The planet appears to be moving at its fastest motion against the background.
The planet is invisible in the sky because it is moving toward Earth.
The planet’s motion against the background will appear to be normal, that is, direct motion, because apparent motion is always constant in a circular orbit.

Ans: A
Section: 2-3

What is the angle between the line from Earth to Mercury and the line from Mercury to the Sun when Mercury is at greatest elongation?
A) 90°
B) 180°
C) anywhere between 0° and 180°, depending on the particular planetary alignment
D) 0°

Ans: A
Section: 2-3

When Saturn is at its farthest distance from Earth, it is at: A)
inferior conjunction.
B) opposition.
C) greatest elongation (about 47° from the Sun).
D) conjunction.

Ans: D
Section: 2-3

When Mars is at opposition, it is: A)
high in the sky at midnight.
B) high in the sky at sunset.
C) high in the sky at noon.
D) rising at about midnight.

Ans: A
Section: 2-3

Where and when would Jupiter be seen from Earth when it is at opposition? A) in the daytime sky
B) just before sunrise, on the eastern horizon
C) just after sunset, on the western horizon
D) high in the south at midnight

Ans: D
Section: 2-3

When a planet is seen at opposition, it is always at its: A) most distant point from the Sun.
B) closest point to the Sun.
C) most distant point from Earth.
D) closest point to Earth.

Ans: D
Section: 2-3

Which of the following planetary configurations is IMPOSSIBLE for an inferior planet?
A) superior conjunction
B) greatest elongation
C) inferior conjunction
D) opposition

Ans: D
Section: 2-3

The planet Venus can NEVER reach which planetary configuration when viewed from Earth?
A) opposition
B) superior conjunction
C) inferior conjunction
D) greatest elongation

Ans: A
Section: 2-3

Which of the following planetary configurations is NOT possible for the planet Mercury?
A) inferior conjunction
B) superior conjunction
C) greatest elongation
D) opposition

Ans: D
Section: 2-3

What is the angle between the line from Earth to Jupiter and the line from Earth to the Sun when Jupiter is at opposition?
A) 90°
B) anywhere between 0° and 180°, depending on the particular planetary alignment
C) 0°
D) 180°

Ans: D
Section: 2-3

When Jupiter is at opposition, it will rise at: A)
sunrise.
B) noon. C)
sunset. D)
midnight.

Ans: C
Section: 2-3

Jupiter will be at which configuration when it is at the middle of its retrograde motion?

maximum eastern elongation
conjunction
Jupiter never undergoes retrograde motion because it is a superior planet.
opposition

Ans: D
Section: 2-3

When Saturn is closest to Earth, it is at:
A) greatest elongation (about 47° from the Sun).
B) opposition.
C) conjunction.
D) inferior conjunction.

Ans: B
Section: 2-3

The sidereal period of a planet is defined as the time between two successive: A) passages of the planet in front of a particular point in the sky (e.g., a star) as seen from the Sun.
B) passages of the planet in front of a particular point in the sky (e.g., a star) as seen from Earth.
C) identical configurations (e.g., opposition to opposition).
D) greatest elongations (e.g., greatest western elongation to greatest eastern elongation).

Ans: A
Section: 2-3

119. The synodic period of a planet is defined as the time between two successive:
greatest elongations (e.g., greatest western elongation to greatest eastern elongation).
passages of the planet in front of a particular point in the sky (e.g., a star) as seen from Earth.
passages of the planet in front of a particular point in the sky (e.g., a star) as seen from the Sun.
identical configurations (e.g., opposition to opposition).

Ans: D

Section: 2-3

The time period between two successive passages of a planet through the position of opposition is:
A) 1 year.
B) its sidereal period.
C) its synodic period.
D) its precessional period.

Ans: C
Section: 2-3

The synodic period of a superior planet as it moves around the Sun as viewed from Earth is defined as the time between:
A) conjunction and opposition on any orbit.
B) two successive passages through identical configurations, for example, two successive conjunctions.
C) two successive appearances of the planet at its highest point in the observer's sky.
D) two successive passages of Earth through the vernal equinox.

Ans: B
Section: 2-3

The time interval between two successive repeated positions of a planet with respect to the Sun and Earth in its orbit, such as conjunction to conjunction, is known as: A) 1 day.
B) the planet's synodic period.
C) 1 year.
D) the planet's sidereal period.

Ans: B
Section: 2-3

123. The time period between two successive passages of a planet past a particular star

as seen from the Sun is its:
synodic period.
sidereal period.
precessional period.
rotational period.

Ans: B
Section: 2-3

What is the difference between the synodic and sidereal periods of a planet? A)
The synodic period refers to the planet's period with respect to Earth's motion, whereas the sidereal period is the true period with respect to the background stars.
B) There is no difference; they are one and the same time period. The synodic period is the name used in the geocentric theory, whereas the sidereal period is the name used in the heliocentric theory.
C) The synodic period refers to the planet's motion with respect to the background stars, whereas the sidereal period is the true period with respect to Earth's motion.
D) The synodic period refers to the planet's rotation around its axis, whereas the sidereal period is the time for one orbit.

Ans: A
Section: 2-3

A planet's sidereal year is different from its synodic year because the: A)
Earth moves.
B) planet's speed changes along its elliptical orbit.
C) planet rotates about its own axis in addition to its orbital motion.
D) the planet moves.

Ans: A
Section: 2-3

How did Copernicus know Jupiter's orbit around the Sun was larger than Earth's? A)
Jupiter can always be seen relatively close to the Sun
B) He measured Jupiter's orbital period and used Kepler's third law.
C) Jupiter was sometimes seen to pass behind the Sun.
D) Jupiter can be high in the sky at midnight.

Ans: D
Section: 2-3

How did Copernicus know Mercury was closer to the Sun than Earth is? A)
Mercury can always be seen relatively close to the Sun.
B) He measured Mercury's orbital period and used Kepler's third law.
C) Mercury was sometimes seen to pass behind the Sun.
D) Mercury can be high in the sky at midnight.

Ans: A
Section: 2-3

The maximum elongation of the orbit of Saturn is:
A)46.
B)90. C)
120 . D)
180 .

Ans: D
Section: 2-3

The greatest inaccuracy in Copernicus's theory of the solar system was: A)
no allowance for retrograde motion.
B) placement of the planets on epicycles, the centers of which followed orbits around the Sun.
C) the assumption that the planets move in elliptical orbits with constant speeds rather than variable speeds.
D) placement of the planets in circular orbits.

Ans: D
Section: 2-3

The reason Copernicus's heliocentric theory soon came to be regarded as preferable to the geocentric theory of Ptolemy is that the heliocentric theory accounted for:

the observed motions of the planets using complex constructions called epicycles and deferents, so it was considered more reliable than the geocentric theory.
the same observed motions of the planets as the geocentric theory but did so in a much simpler way.
retrograde motion, which the geocentric theory was unable to explain.
the same observed motions of the planets as the geocentric theory but did so much more accurately.

Ans: B
Section: 2-3

Which of the following statements about Copernicus's system of planetary motion is CORRECT?
A) Copernicus's system of planetary motion had Earth in the center of the solar system.
B) Copernicus's system of planetary motion was the first model in history to place the Sun is the center of the solar system.
C) Copernicus's system of planetary motion used uniform circular motion.
D) Copernicus's system of planetary motion included a physical explanation of why the planets move in their particular orbits.

Ans: C
Section: 2-3

Retrograde motion was important in the development of our understanding of the solar system because:
A) it was not discovered until 1920.
B) it cannot be described with the geocentric model.
C) its description in terms of the heliocentric model is a great simplification in comparison with its description in terms of the geocentric model.
D) it happens only about once per century.

Ans: C
Section: 2-3

Retrograde motion was a major source of difficulty in designing a theoretical model of the solar system. What is the explanation for retrograde motion?
A) The planets actually stop and reverse direction in their orbits.

The planets move not in uniform circular motion about the Sun, but rather in circular orbits (epicycles) about points that themselves move about the Sun in circular orbits.
Retrograde motion is an apparent motion of other planets, which we observe only because we are viewing their motion from Earth, itself in motion around the Sun.
Retrograde motion is an apparent motion caused by the precession of Earth's rotation axis.

Ans: C
Section: 2-3

Which one of the following bodies would NOT exhibit retrograde motion if observed from Mercury?
A) Venus
B) Earth
C) the Sun
D) Mars

Ans: C
Section: 2-3

Consider the synodic period for Jupiter. Which planet (or planets) will be in the same place in its orbit at the beginning and at the end of one synodic period of Jupiter? A) neither Jupiter nor Earth
B) Earth but not Jupiter
C) Jupiter but not Earth
D) both Jupiter and Earth

Ans: A
Section: 2-3

Consider the synodic period for Saturn. Which planet (or planets) will be in the same place in its orbit at the beginning and at the end of one synodic period of Saturn? A) neither Saturn nor Earth
B) Earth but not Saturn
C) Saturn but not Earth
D) both Saturn and Earth

Ans: C
Section: 2-3

The time from one inferior conjunction of Mercury to the next is 116 days. The time from inferior conjunction of Mercury to the next superior conjunction is:
A) 58 days.
B) 116 days.
C) 174 days.
D) 365 days.

Ans: A
Section: 2-3

Ptolemy's system of the heavens put Earth at or near the center. The motivation for this choice was primarily:
A) religious, placing mankind at the center of creation.
B) religious, relegating Earth to an inferior position outside the perfect celestial realm.
C) based on observations.
D) based on the mathematics of the Pythagoreans.

Ans: C
Section: 2-3

Venus experiences all of the following EXCEPT ONE. Which is the exception? A) inferior conjunction
B) superior conjunction
C) opposition
D) maximum elongation

Ans: C
Section: 2-3

Saturn experiences all of the following EXCEPT ONE. Which is the exception? A) inferior conjunction
B) superior conjunction
C) opposition
D) maximum elongation

Ans: A
Section: 2-3

141. Parallax:
of stars was measured by Tycho.
is too small to be measured for stars.
can be measured by an observer moving relative to a background.
is a larger value for distant objects than it is for closer objects.

Ans: C
Section: 2-4

The “new star” observed by Tycho in 1572 was assumed by many to be close to Earth. Why?
A) Most people believed that Tycho had made errors in his parallax measurements.
B) They thought they could see clouds moving between Earth and the star.
C) Plato and Aristotle had taught that the universe beyond Earth was unchanging.
D) The star moved too rapidly to be far away.

Ans: C
Section: 2-4

The observation by Tycho Brahe of a supernova in 1572 was significant because it: A) showed a parallax (relative apparent motion) that proved it to be more distant than the Moon.
B) showed motion in a circular orbit.
C) proved Kepler’s three laws.
D) proved the heliocentric theory.

Ans: A
Section: 2-4

144. What use did Tycho Brahe make of parallax in his observations?
Tycho did not attempt to measure parallax because he knew it applied only to heliocentric systems—and he believed that the solar system was geocentric.
Tycho did not attempt to measure parallax because he knew it applied only to geocentric systems—and he believed that the solar system was heliocentric.
Tycho successfully measured parallax for the supernova of 1572 and the comet of 1577.
Tycho tried but failed to measure parallax for the stars.

Ans: D
Section: 2-4

Tycho demonstrated that the supernova of 1572 was far from Earth by showing that:
A) the object was moving in our direction.
B) it did not appear to move against the background of stars.
C) its spectrum was shifted to the red.
D) it disappeared behind the Sun.

Ans: B
Section: 2-4

Tycho made angular measurements with an accuracy of one arc minute. If Mars takes 2.136 years to complete one orbit of the Sun as viewed from Earth (a synodic period), how long on the average does it take Mars to move through one arc minute? A) one second
B) a little less than one hour
C) about a day and a half D)
17 days

Ans: B
Section: 2-4

147. What was Tycho Brahe's conclusion about the nature of the solar system?
Tycho observed the phases of Venus and thus concluded that the solar system is heliocentric.
Tycho's observation of the Jovian system (Jupiter and its four large moons)

convinced him that the solar system is heliocentric.
Tycho's failure to detect parallax motion for the stars convinced him that the solar system is geocentric.
Tycho's observations of the Sun convinced him that it is so large that it must be the center of the solar system.

Ans: C
Section: 2-4

What was Tycho Brahe's conclusion regarding his parallax measurements of the stars?
A) The parallax motion occurred too quickly for Tycho to detect with the equipment available to him at the time. Thus, he concluded that Earth is motionless.
B) The parallax motion was too small for Tycho to detect with the equipment available to him at the time. Thus, he concluded that Earth is motionless.
C) Tycho was able to measure parallax motion for the stars and thus concluded that the solar system is geocentric.
D) Tycho was able to measure parallax motion for the stars and thus concluded that the solar system is heliocentric.

Ans: B
Section: 2-4

149. The phenomenon of parallax is the:
change in the apparent position of a nearby object compared with background objects as a result of the motion of the object.
change in direction of motion of a planet from retrograde to direct motion.
apparent change in angular size of an object as it moves toward or away from an observer.
change in apparent position of a nearby object compared with background objects as a result of the motion of the observer.

Ans: D
Section: 2-4

Tycho Brahe demonstrated that the supernova of 1572 was NOT a nearby event (close to Earth) by:

proving that it did not show parallax over the course of one night.
showing that it did not pass in front of the Sun at conjunction.
proving that it did not move past the background stars like a planet in our solar system.
showing that it did not get brighter and fainter as Earth moved toward and away from it over the course of a year.

Ans: A
Section: 2-4

The major contribution of Tycho Brahe to the development of modern astronomy was:
A) using parallax to prove that Earth moves around the Sun.
B) observing the phases of Venus.
C) measuring planetary positions very accurately.
D) proving that planetary orbits are ellipses.

Ans: C
Section: 2-4

152. Tycho Brahe:
developed a reflecting telescope, which used a curved mirror to focus the light.
developed the first detailed heliocentric model for the solar system, which replaced the geocentric model of Ptolemy.
improved the refracting telescope, which allowed him to extend Galileo's observations of the sky.
made accurate measurements of planetary positions, which Kepler later used to find the shapes of planetary orbits.

Ans: D
Section: 2-4

The person who compiled the large set of accurate observations of planetary positions that formed the basis for proving that planets move in elliptical orbits around the Sun was:
A) Ptolemy.
B) Johannes Kepler.

Nicolaus Copernicus.
Tycho Brahe.

Ans: D
Section: 2-4

Before deriving the shapes of planetary orbits, Johannes Kepler worked as an assistant to:
A) Tycho Brahe.
B) Galileo Galilei.
C) Nicolaus Copernicus.
D) Ptolemy.

Ans: A
Section: 2-4

Kepler as a young man became the assistant to: A)
Nicolaus Copernicus.
B) Ptolemy.
C) Tycho Brahe.
D) Sir Isaac Newton.

Ans: C
Section: 2-4

The Danish astronomer Tycho Brahe had a young assistant who became famous himself some time later. His name was:
A) Nicolaus Copernicus.
B) Galileo Galilei.
C) Johannes Kepler.
D) Ptolemy.

Ans: C
Section: 2-4

The person who was an assistant to the Danish astronomer Tycho Brahe before becoming famous himself was:
A) Sir Isaac Newton.
B) Galileo Galilei.
C) Nicolaus Copernicus.
D) Johannes Kepler.

Ans: D
Section: 2-4

A significant contribution of Kepler to our understanding of the solar system was the:
A) discovery that Earth orbits the Sun.
B) discovery that planetary orbits are not circular.
C) observation of the phases of Venus.
D) idea of a gravitational force between Earth and the Sun.

Ans: B
Section: 2-5

The planet Jupiter travels in an elliptical orbit. The Sun is at one focus of this ellipse. What is at the other focus?
A) Earth
B) Ganymede, the largest of Jupiter's moons
C) Trojan asteroids
D) nothing

Ans: D
Section: 2-5

Each planet moves along an elliptical path, with the Sun at one focus of the ellipse. What is at the other focus?
A) the Moon
B) Vulcan
C) the Great Attractor
D) nothing

Ans: D
Section: 2-5

Consider a comet in a long, thin elliptical orbit with a semimajor axis of one astronomical unit. What can you say about the sidereal period of this comet?
A) The sidereal period will be less than one year.
B) The sidereal period will be one year.
C) The sidereal period will be more than one year.
D) It is not possible to determine the comet's sidereal period without knowing the eccentricity of its orbit.

Ans: B
Section: 2-5

A major contribution of Johannes Kepler to the development of modern astronomy was:
A) the development of the first mathematical heliocentric model of the solar system.
B) proof that planetary orbits are ellipses.
C) the use of parallax to prove that Earth moves around the Sun.
D) observation of the satellites (moons) of Jupiter.

Ans: B
Section: 2-5

The person who first showed that planetary orbits are ellipses was: A) Copernicus.
B) Newton.
C) Galileo.
D) Kepler.

Ans: D
Section: 2-5

164. The model of the solar system that Johannes Kepler proposed was:

Earth-centered, with the Sun, the Moon, and the planets moving in ellipses.
Sun-centered, with elliptical planetary orbits.
Sun-centered, with planets moving in circles around it.
Earth-centered, with planets moving in epicycles.

Ans: B
Section: 2-5

The *phenomenological* approach in science consists of sifting through large amounts of data and trying to fit them into an equation in the hope that the form of the equation will provide a clue to the underlying physics. Whose work was an example of this approach?
A) Pythagoras
B) Copernicus
C) Kepler
D) Newton

Ans: C
Section: 2-5

Kepler's first law states that a planet moves around the Sun in a(n): A) circle, with the Sun at the center.
B) elliptical orbit, with the Sun at one focus.
C) elliptical orbit, with the Sun on the minor axis of the ellipse.
D) elliptical orbit, with the Sun at the center of the ellipse.

Ans: B
Section: 2-5

Kepler's first law states that the orbit of a planet about the Sun is a(n): A) circle, with the Sun at the center.
B) oval, with the Sun at the center.
C) ellipse, with the Sun at one focus.
D) ellipse, with the Sun at the center.

Ans: C
Section: 2-5

Mars moves in an elliptical orbit around the Sun. The Sun is located at: A)
the exact center of the ellipse.
B) the focus of the ellipse that is closer to the point where Mars moves fastest.
C) one end of the major axis of the ellipse.
D) the focus of the ellipse that is closer to the point where Mars moves slowest.

Ans: B
Section: 2-5

169. The eccentricity of a planet's orbit describes:
the tilt of the planet's spin axis with respect to its orbital plane.
its shape compared with that of a circle.
its motion at any specific point in its orbit as seen from Earth, that is, whether direct, retrograde, or stationary.
its tilt with respect to the plane of Earth's orbit (the ecliptic plane).

Ans: B
Section: 2-5

If an object has an orbit around the Sun that has an eccentricity of 0.1, then the orbit is:
A) exactly circular.
B) a straight line.
C) a long, thin ellipse.
D) almost circular, but not quite.

Ans: D
Section: 2-5

A perfect circle is an ellipse with an eccentricity of: A)
zero.
B) one.
C) pi.

D) infinity.

Ans: A
Section: 2-5

If an object has an orbit around the Sun that has an eccentricity of 0.8, then the orbit is:
A) almost circular, but not quite.
B) a straight line.
C) exactly circular. D)
a long, thin ellipse.

Ans: D
Section: 2-5

The distance from the perihelion point to the aphelion point of a planetary orbit is: A)
equal to the distance between the foci.
B) the major axis.
C) the minor axis.
D) the semimajor axis.

Ans: B
Section: 2-5

The distance between a planet's aphelion point and its perihelion point is: A)
the semimajor axis of its ellipse.
B) twice the semimajor axis of its ellipse.
C) the eccentricity of its ellipse.
D) twice the eccentricity of its ellipse.

Ans: B
Section: 2-5

175. In an ellipse, the major axis is a distance measured:

from focus to focus.
along the longer diameter, passing through the foci of the ellipse.
along the shorter diameter.
along the circumference, between the closest point to and the farthest point from one focus.

Ans: B
Section: 2-5

176. The semimajor axis of an ellipse is:
the distance from the center of the ellipse to one end, along the largest diameter of the ellipse.
the distance from the center to one side of the ellipse, along the shortest diameter of the ellipse.
the distance from one focus to any point on the circumference of the ellipse.
half the distance between the foci of the ellipse.

Ans: A
Section: 2-5

To which point in a planetary orbit does the word *perihelion* refer? A)
the point farthest from the Sun
B) the precise center of the orbit
C) the "other" focus (the one not occupied by the Sun)
D) the point closest to the Sun

Ans: D
Section: 2-5

To which point in a planetary orbit does the word *aphelion* refer? A)
the precise center of the orbit
B) the point farthest from the Sun
C) the "other" focus (the one not occupied by the Sun)
D) the point closest to the Sun

Ans: B
Section: 2-5

Which point in a comet's orbit is closest to the Sun? A)
perihelion
B) inferior conjunction
C) greatest elongation
D) aphelion

Ans: A
Section: 2-5

At which point in a planet's elliptical orbit is the planet farthest from the Sun? A)
aphelion
B) quadrature
C) perihelion
D) superior conjunction

Ans: A
Section: 2-5

Where is a planet when it is moving MOST rapidly in its orbit? A)
at aphelion
B) at perihelion
C) approaching the closest distance to the Sun
D) at the focus of its orbit

Ans: B
Section: 2-5

At what point in a planetary orbit is the planet's speed the slowest? A)
approaching the closest distance to the Sun
B) at aphelion
C) at perihelion
D) at the focus of its orbit

Ans: B
Section: 2-5

In any one day, the line joining a planet to the Sun will sweep through some particular angle as seen from the Sun. Where is the planet when this angle has its smallest value?
A) at aphelion
B) at perihelion
C) at greatest elongation
D) at inferior conjunction

Ans: A
Section: 2-5

Kepler's second law states that a planet moves fastest when it: A)
passes through the minor axis.
B) is closest to the Sun.
C) is farthest from the Sun.
D) is at conjunction.

Ans: B
Section: 2-5

Kepler's second law states that a line joining a planet to the Sun: A)
moves equal distances along the planet's orbit in equal times.
B) sweeps through equal angles in equal times.
C) points in the same direction at all times.
D) sweeps out equal areas in equal times.

Ans: D
Section: 2-5

Two of Kepler's laws of planetary motion applied to Earth are that the radius vector from the Sun to Earth sweeps out equal areas in equal times and that Earth's orbit is an

ellipse with the Sun at one focus. One consequence of these laws is that:
Earth must rotate on its axis.
the Sun must rotate on its axis.
Earth moves at different orbital speeds at different times of the year.
Earth's orbital plane lies in the same plane as the orbits of the other planets.

Ans: C
Section: 2-5

If the line joining a planet to the Sun sweeps out a particular area in one day, then in two days it will sweep out:
A) less than twice the area if the planet is approaching perihelion and more than twice the area if it is leaving perihelion.
B) half the area.
C) more than twice the area if the planet is approaching perihelion and less than twice the area if it is leaving perihelion.
D) exactly twice the area.

Ans: D
Section: 2-5

Kepler's third law, the harmonic law, provides a relationship between a planet's orbital:
A) period and the length of the semimajor axis.
B) eccentricity and the length of the semimajor axis.
C) period and orbital eccentricity.
D) period and mass.

Ans: A
Section: 2-5

Kepler's third law, $P^2 = a^3$, applies to each of the following situations EXCEPT ONE. Which is the exception?
A) the orbit of Mercury
B) the orbit of Jupiter C)
the orbit of the Moon
D) the orbit of Halley's Comet

Ans: C
Section: 2-5

190. Kepler's third law tells us that the:
period of a planet in years is the same number as its semimajor axis in AU.
square of a planet's period in years is the same number as the cube of its semimajor axis in AU.
square of a planet's period in years is the same number as the fourth power of its semimajor axis in AU.
cube of a planet's period in years is the same number as the square of its semimajor axis in AU.

Ans: B
Section: 2-5

191. Kepler's third law can be described in which of the following ways?
The time to complete one revolution of its orbit depends on the size or radius of the planet.
The smaller the radius of a planet, the more rapidly it rotates on its axis.
The smaller the orbit of a planet, the longer the planet takes to complete one revolution.
The larger the orbit of a planet, the longer the planet takes to complete one revolution.

Ans: D
Section: 2-5

191. Kepler's third law, as derived by Newton from the law of gravitation, applies:
to all situations where two objects orbit each other solely under the influence of their mutual gravitational attraction.
only to situations similar to planets orbiting the Sun, where the mass of the orbiting body is small compared with the mass of the object being orbited.
accurately only close to the Sun and becomes less accurate with increasing distance from the Sun.
only to planets orbiting the Sun.

Ans:  A
Section:  2-5 and 2-7

The simplified version of Kepler’s third law of planetary motion relates the period $P$ (in sidereal years) to the length of the semimajor axis $a$ (in astronomical units) in which way?
A) $P^2 = a^3$
B) $P = a^2$
C) $P = 1/a^2$
D) $P^3 = a^2$

Ans: A
Section:  2-5

In the simplified version of Kepler’s third law, $P^2 = a^3$, the units of the orbital period $P$ and the semimajor axis of the ellipse $a$ must be, respectively:
A)  years and light-years.
B) years and astronomical units.
C) years and meters.
D) seconds and meters.

Ans: B
Section:  2-5

A space probe is put into a circular orbit around the Sun at a distance of exactly 2 AU from the Sun. According to Kepler’s third law, how long does it take this probe to orbit the Sun once?
A) 1.6 years (cube root of 4)
B) 1 year
C) 8 years
D) 2.8 years (square root of 8)

Ans: D
Section:  2-5

A distant asteroid is discovered that takes 50 years to orbit the Sun once. According to Kepler's third law, what is the average distance of this asteroid from the Sun?
A) 2500 AU
B) 50 AU
C) 353 AU (square root of 125,000)
D) 13.6 AU (cube root of 2500)

Ans: D
Section: 2-5

If a tenth planet (tentatively predicted to exist on the basis of perturbations in the orbits of Uranus and Neptune) were to be discovered with a sidereal period of 125 years, what would be the radius of its orbit (assumed to be circular)?
A) 8.55 AU
B) 125 AU
C) 1AU D)
25 AU

Ans: D
Section: 2-5

If a tenth planet (tentatively predicted to exist on the basis of perturbations in the orbits of Uranus and Neptune) were to be discovered with a sidereal period of 200 years, what would be the radius of its orbit (assumed to be circular)?
A) 2828 AU
B) 34.2 AU
C) 342 AU
D) 200 AU

Ans: B
Section: 2-5

According to Kepler's law, the approximate sidereal period of an asteroid moving around the Sun in the asteroid belt is:
A) 2.8 years.

46.8 years.
1.99 years.
4.68 years.

Ans: D
Section: 2-5

If a planet were to exist in our solar system in a circular orbit with a radius of 3 AU, about how long would it take to orbit the Sun once?
A) 5.2 years
B) 2.1 years
C) 27 years
D) 3 years

Ans: A
Section: 2-5

Suppose an asteroid is discovered with an elliptical orbit, a period of exactly one year, and perihelion 0.5 AU from the Sun. Using Kepler's third law, how far from the Sun is this asteroid at aphelion? (Drawing a diagram of the orbit, including the Sun, will help.)
A) 2.5 AU
B) 2.0 AU
C) 1.0 AU
D) 1.5 AU

Ans: D
Section: 2-5

Halley's Comet returns to the Sun's vicinity approximately every 76 years in an elliptical orbit. According to Kepler's third law, what is the semimajor axis of this orbit? A) 0.59 AU
B) 17.9 AU
C) 50.000 AU
D) 1AU

Ans: B

Section: 2-5

If Halley's Comet has an elliptical orbit with a semimajor axis of 17.5 AU, approximately how far out into the planetary system does it reach at its farthest point (aphelion)? (Assume that perihelion distance from the Sun is negligible. Be careful—the question needs some thought.)
A) between the orbits of Saturn and Uranus
B) between the orbits of Uranus and Neptune
C) between the orbits of Neptune and Pluto
D) beyond the orbit of Pluto

Ans: C
Section: 2-5

A comet is observed to return to the vicinity of the Sun on a long elliptical orbit with a period of 31.7 years. What is the semimajor axis of the orbit?
A) 31.7 AU
B) 178.5 AU
C) 10 AU D)
1000 AU

Ans: C
Section: 2-5

An asteroid-like object (or a cometary nucleus) is seen to be orbiting the Sun in a circular path with a period of 120 years. What is its distance of closest approach to Earth (the separation distance when the object is at opposition)? (Be careful with your answer; a diagram might be helpful.)
A) 1314.5 AU
B) 24.33 AU
C) 25.33 AU
D) 23.33 AU

Ans: D
Section: 2-5

Why do astronomers need special units, in addition to the metric system of units such as meters and kilograms, to describe the universe?
A) Distances and masses are very large, and representing them in metric units is cumbersome.
B) Metric units cannot represent correctly the curvature of space observed by astronomers.
C) Units used in the metric system are known to be insufficiently accurate to satisfy the precision needed in modern astronomy.
D) Metric units are too large to represent astronomical quantities with sufficient precision.

Ans: A
Section: Discovery 2-2

One light-year is a distance of approximately: A)
$6.3 \times 10^4$ km.
B) $3 \times 10^5$ km.
C) $9.5 \times 10^{12}$ km.
D) $1.5 \times 10^8$ km.

Ans: C
Section: Discovery 2-2

A light-year is a measure of: A)
angle.
B) arc length along an orbit.
C) distance.
D) time.

Ans: C
Section: Discovery 2-2

208. One light-year is the:
distance that light travels in one year.
time taken for Earth to orbit the Sun once.

distance between Earth and the Sun.
time taken for light to travel from the Sun to Earth.

Ans: A
Section: Discovery 2-2

209. 1 AU, or 1 astronomical unit, is defined as the:
distance at which the Earth-Sun distance will subtend an angle of 1 arc second.
mean distance between the Sun and Earth.
radius of the Sun.
distance traveled by light in one year.

Ans: B
Section: Discovery 2-2

210. An astronomical unit (AU) is a unit of:
time equal to the time taken for light to travel from the Sun to Earth.
length, defined as the wavelength of light from krypton gas.
length, the average distance between the Sun and Earth.
mass equal to one solar mass.

Ans: C
Section: Discovery 2-2

If we sent a radio message toward the star nearest to the Sun, and intelligent beings from a planet near the star sent back a reply immediately on receipt of the message, how long after our transmission would we have to wait for a reply?
A) 8.6 years B)
1 light-year C)
1 year
D) 20,000 years

Ans: A
Section: Discovery 2-2 and Appendix, Table C-5

If a supernova was first seen in the year of Christ's birth (the Star of Bethlehem?) and its distance from Earth was 3 kpc, approximately when did the supernova actually explode?
A) 10 B.C. B)
3000 B.C. C)
3 B.C.
D) 10,000 B.C.

Ans: D
Section: Discovery 2-2

Light from fires that were lit at the time of the Battle of Hastings in England in A.D. 1066 has traveled out into space at the speed of light. How far out into space has this light now reached, compared with the distances to the 20 brightest stars (see Appendix, Table C-6, Comins, *Discovering the Essential Universe*, 6th ed.)?
A) beyond Sirius, but not beyond Betelgeuse, Rigel, and Deneb B)
beyond Sirius, Betelgeuse, and Rigel, but not beyond Deneb C)
beyond Sirius and Betelgeuse, but not beyond Rigel and Deneb D)
beyond Sirius, Betelgeuse, Rigel, and Deneb

Ans: B
Section: Discovery 2-2

Suppose that, at the same time on the same night, we see two supernovas (exploding stars) explode in the night sky. If one is in the Andromeda Galaxy, 2 million light-years away from us, and the other is in the galaxy M82, 6 million light-years away from us, which of the following statements concerning the actual explosion times of these supernovas is CORRECT?
A) We cannot tell which star actually exploded first because both stars are so far away.
B) The supernova in the Andromeda Galaxy actually occurred after the one in M82.
C) We know both stars exploded at the same time because we saw the explosions at the same time.
D) The supernova in the Andromeda Galaxy actually occurred before the one in M82.

Ans: B
Section: Discovery 2-2

Suppose we were to observe two supernovas (exploding stars) exploding in the night sky on a particular night. If one was in the nearby arm of the Milky Way Galaxy while the other was in the Andromeda Galaxy, M31, 2 million light-years away from us, which of the following statements concerning the actual explosion times of these supernovas is CORRECT?
A) We know both stars exploded at the same time because we saw the explosions at the same time.
B) We cannot tell which star actually exploded first because both stars are so far away.
C) The supernova in the Andromeda Galaxy actually occurred after the one in our Galaxy.
D) The supernova in the Andromeda Galaxy actually occurred before the one in our Galaxy.

Ans: D
Section: Discovery 2-2

In A.D. 2012, an inhabitant of a planet orbiting a distant star observed the flash of the first nuclear explosion on Earth, which occurred in July 1945. Approximately how far away is his solar system from Earth?
A) 219 pc
B) 20.6 pc
C) about 0.07 pc
D) 2.06 pc

Ans: B
Section: Discovery 2-2

An inhabitant of a planet orbiting the star Betelgeuse observes the flash from the first nuclear weapon on Earth, exploded in July 1945. If this extraterrestrial being were to send a signal to Earth immediately to confirm this sighting by exploding a bomb of equivalent brightness, and astronomers on Earth were watching his planet, when would they expect to see the flash?
A) A.D. 2076
B) A.D. 2207
C) A.D. 2799
D) A.D. 2372

Ans: C
Section: Discovery 2-2 and Appendix, Table C-6

The time taken for light to travel from a galaxy that is 10 Mpc away is: A) $3.07 \times 10^6$ years.
B) 32.6 years.
C) $10^7$ years.
D) $3.26 \times 10^7$ years.

Ans: D
Section: Discovery 2-2

If light takes about 8.3 minutes to travel from the Sun to Earth, approximately how much longer would light take to travel from Jupiter to Earth when Jupiter is at conjunction (appearing closest to the Sun in our sky) than when it is at opposition (on the opposite side of Earth from the Sun)? (Assume that light from Jupiter is not blocked by the Sun at conjunction. A diagram might help.)
A) 8.3 minutes
B) 16.6 minutes
C) 43.2 minutes
D) There is insufficient information to answer the question.

Ans: B
Section: Discovery 2-2

The Crab Nebula is the result of a supernova explosion of a star that occurred at a distance of about 1.84 kpc from Earth. If people first saw the explosion in A.D. 1054, when did the explosion actually occur?
A) about A.D.1048
B) 786 B.C.
C) A.D. 1054, of course
D) about 4946 B.C.

Ans: D
Section: Discovery 2-2

If you were to look back from your spacecraft toward the solar system and you measured that the angle between Earth and the Sun was 1 second of arc, how far from the Sun would you be? (Assume that the Earth-Sun line is at right angles to your line of sight.)
A) 1 Mpc
B) 1AU
C) 1 pc
D) 1 ly

Ans: C
Section: Discovery 2-2

The distance from Earth to the star Betelgeuse (in the constellation Orion) has been measured as 131 pc. Expressed in light-years, the distance is approximately:
A) 0.025 ly.
B) 40 ly. C)
427 ly. D)
4270 ly.

Ans: C
Section: Discovery 2-2

The distance to a certain star has been measured to be 750 ly. Expressed in parsecs, the distance is approximately:
A) 23 pc.
B) 230 pc.
C) 750 pc because these units are identical.
D) 2445 pc.

Ans: B
Section: Discovery 2-2

A certain star is found to be 340 ly from Earth. Expressed in parsecs, the distance is approximately:
A) 750 pc.
B) 105 pc.
C) 0.340 kpc (kiloparsecs).

D) 1100 pc.

Ans: B
Section: Discovery 2-2

A certain star in our arm of the Milky Way is measured to be about 750 pc from Earth. Expressed in light-years, the distance is approximately:
A) 1500 ly.
B) $4.7 \times 10^{7}$ ly.
C) 230 ly.
D) 2445 ly.

Ans: D
Section: Discovery 2-2

One convenient statement of the distance traveled by light over very short times is that the speed of light is about “a foot per nanosecond.” The speed of light is $3 \times 10^{8}$ m/s. What, then, is a nanosecond?
A) $10^{-7}$ seconds
B) $10^{-9}$ seconds
C) $10^{-12}$ seconds
D) $10^{-15}$ seconds

Ans: B
Section: Discovery 2-2

The average distance from the Sun to Earth is $1.50 \times 10^{11}$ meters. The speed of light is $2.99 \times 10^{8}$ m/s. So the Astronomical Unit could also be expressed as:
A) about a thousand light seconds.
B) about 8.3 light minutes.
C) about $1.6 \times 10^{-4}$ light years..
D) about $4.9 \times 10^{-5}$ parsecs.

Ans: B
Section: Discovery 2-2

If an astronomer finds an object at a distance of 6.8 AU from Earth, what is the object MOST likely to be?
A) a star in our Galaxy
B) a distant galaxy
C) an artificial satellite orbiting Earth
D) a comet in our solar system

Ans: D
Section: Discovery 2-2

An astronomer finds an object at a distance of 5.6 pc from Earth. At this distance, what is the object MOST likely to be?
A) a star in our Galaxy
B) an asteroid in our solar system
C) an artificial satellite orbiting Earth
D) a distant galaxy

Ans: A
Section: Discovery 2-2

An astronomer discovers an object at a distance of 28 Mpc from Earth. At this distance, what is the object MOST likely to be?
A) a comet in our solar system
B) a star in our Galaxy
C) an artificial satellite orbiting Earth
D) a distant galaxy

Ans: D
Section: Discovery 2-2

What is the distance between Earth and the nearest star? A)
4.3 pc
B) 1AU
C) 5.2 AU
D) 4.3 ly

Ans:  B
Section:  Discovery 2-2

The semimajor axis of Earth's orbit is: A)
$10^6$ km.
B) 1 AU.
C) 1 pc.
D) 1 kpc.

Ans:  B
Section:  2-6 and Discovery 2-2

233. Place the following events in chronological order, from earliest to latest.
Copernicus's heliocentric model, Kepler's third law, Galileo's discovery of Jupiter's moons
Kepler's third law, Copernicus's heliocentric model, Galileo's discovery of Jupiter's moons
Copernicus's heliocentric model, Galileo's discovery of Jupiter's moons, Kepler's third law
Kepler's third law, Galileo's discovery of Jupiter's moons, Copernicus's heliocentric model

Ans:  C
Section:  2-5 and 2-6

Galileo's observations suggested to him that the planets revolve around the Sun. This idea was:
A) original to Galileo and had not been suggested before.
B) similar to the teachings of the Roman Catholic Church.
C) similar to the ideas of Ptolemy.
D) similar to the ideas of Copernicus.

Ans: D
Section:  2-6

Why did Galileo's observations of moons orbiting Jupiter disagree with the theory of the universe accepted up to that time in history?
A) The moons moved in noncircular orbits around Jupiter.
B) The moons did not appear to orbit the Sun.
C) The moons appeared to be too small to be considered part of the solar system described by the theory.
D) The moons did not orbit Earth.

Ans: D
Section: 2-6

What fundamental belief about the universe, established by the Greeks and adopted by the early Christian church, was shattered by Galileo's observation of moons orbiting Jupiter?
A) The Moon is the only moon orbiting around a planet in our solar system.
B) Everything in the visible universe must orbit the center of the Milky Way Galaxy.
C) Everything in the universe orbits Earth.
D) Everything in the universe orbits the Sun.

Ans: C
Section: 2-6

In which country did Galileo make his astronomical discoveries? A)
Greece
B) England
C) Italy D)
Poland

Ans: C
Section: 2-6

Who was the first astronomer to use a telescope for viewing the sky? A)
Ptolemy
B) Newton
C) Brahe

D)  Galileo

Ans: D
Section:  2-6

Which of the following astronomers was a contemporary of (lived at the same time as) Galileo?
A)  Newton
B)  Ptolemy
C) Kepler
D) Copernicus

Ans: C
Section:  2-6

Galileo's early observations of the sky with his newly made telescope included the discovery of:
A) Pluto.
B) the phases of Venus.
C) Jupiter's magnetosphere.
D) retrograde motion in planets.

Ans: B
Section:  2-6

The one significant observation Galileo made through his home-built telescope that convinced him that the planets revolved around the Sun was the:
A) appearance of the Milky Way as a mass of individual stars.
B) discovery of rings around the planet Saturn.
C) appearance of mountains and craters on the Moon.
D) appearance of Venus following a cycle of phases, from crescent through quarter and gibbous phases to full.

Ans: D
Section:  2-6

What did Galileo NOT observe with his new telescope? A)
the phases of Venus
B) the large moons of Jupiter
C) Neptune
D) sunspots

Ans: C
Section: 2-6

What did Galileo see when he observed Venus through his telescope? A)
phases like the Moon’s
B) nothing because Venus is perpetually cloud-covered
C) four satellites (moons) orbiting Venus
D) a set of rings

Ans: A
Section: 2-6

244. What did Galileo see when he observed Venus through his telescope?
Venus has an angular size, which increases and decreases markedly but does not show phases (e.g., crescents).
Venus has phases like the Moon and, also like the Moon, is almost constant in angular size.
Venus has phases like the Moon, and its largest angular diameter is at gibbous phase.
Venus has phases like the Moon, and its largest angular diameter is at crescent phase.

Ans: D
Section: 2-6

When viewed from Earth, which of the following planets shows the GREATEST change in angular size over one planetary orbit?
A) Venus
B) Mercury
C) Uranus
D) Jupiter

Ans: A
Section: 2-6

As Venus orbits the Sun, its angular size as viewed from Earth appears to change by what factor, from smallest to largest? (See Figure 2-10, Comins, *Discovering the Essential Universe*, 6th ed.)
A) 58
B) 1.72
C) Its angular size does not change; only its brightness changes.
D) 5.8

Ans: D
Section: 2-6

The angular diameter of Venus appears largest when its phase is: A)
crescent.
B) half.
C) gibbous.
D) full.

Ans: A
Section: 2-6

Galileo observed Venus to go through a full range of phases. Which other planet should also display a full range of phases when viewed from Earth?
A) Mercury
B) Mars C)
Jupiter
D) *any* other planet

Ans: A
Section: 2-6

In the geocentric model of the solar system, which one of the following phases of Venus should be visible from Earth?
A) full
B) new
C) gibbous phase between first quarter and full
D) gibbous phase between third quarter and full

Ans: B
Section: 2-6

In the heliocentric model of the solar system, which of the following phases of Venus should NOT be visible from Earth?
A) full
B) gibbous
C) new
D) None of these; they are all visible.

Ans: D
Section: 2-6

In the geocentric model of the solar system, which of the following phases of Venus should NOT be visible from Earth?
A) full
B) crescent
C) new
D) None of these; they are all visible.

Ans: A
Section: 2-6

Viewed from Earth, the LARGEST angular diameter of Venus occurs when it is at which phase?
A) full
B) gibbous
C) new D)
quarter

Ans: C

Section: 2-6

A planet will be observed (through a telescope) to have a crescent shape whenever it is close to which point as seen from Earth? (It may help to draw a diagram and show the sunlit side of the planet on it.)
A) perihelion
B) superior conjunction
C) opposition
D) inferior conjunction

Ans: D
Section: 2-6

At which point, as seen from Earth, will a planet appear exactly half-lit (looking like the first quarter or last quarter Moon)? (It may help to draw a diagram and show the sunlit side of the planet on it.)
A) greatest elongation
B) opposition
C) inferior conjunction
D) superior conjunction

Ans: A
Section: 2-6

Which of the following observations of the motions of the large moons of Jupiter did Galileo find MOST significant?
A) Their motions are counterclockwise (viewed from the north), just like the orbits of the planets.
B) Their orbits were elliptical, just like Kepler predicted.
C) Their orbits obeyed Kepler's second law.
D) The moons farther from Jupiter had longer periods, just as Copernicus had discovered for the planets around the Sun.

Ans: D
Section: 2-6

According to Galileo's observations of Venus, when Venus is at full phase, its angular size:
A) and its angular distance from the Sun are both maximum.
B) and its angular distance from the Sun are both minimum.
C) is maximum but its angular distance from the Sun is minimum.
D) is minimum but its angular distance from the Sun is maximum.

Ans: B
Section: 2-6

Which of the following statements CORRECTLY states the significance of Galileo's observation that Venus shows phases?
A) The phases showed that, like the Moon, Venus is always much closer to Earth than the Sun is.
B) The phases were correlated with angular size in a way that supported the heliocentric theory.
C) The phases were interesting but did not have any other particular significance.
D) Because the phases were not correlated with angular size, they actually supported the geocentric theory more than the heliocentric theory.

Ans: B
Section: 2-6

Venus shows changes in angular size and also shows phases similar to the phases of the Moon. According to Galileo, who first saw the phases, these observations showed that Venus:
A) orbits Earth in an elliptical orbit.
B) moves in epicycles.
C) does not rotate on its axis.
D) orbits the Sun.

Ans: D
Section: 2-6

259. How many moons of Jupiter did Galileo see?
None; he was unable to see them with the unaided eye.
four
twelve
one

Ans: B
Section: 2-6

Which of the following sentences CORRECTLY states the significance of Galileo's observation that Jupiter has satellites (moons)?
A) The observation showed that Jupiter must be four times the size of Earth (because Jupiter has four moons and Earth has one).
B) The observation showed that bodies can orbit an object other than Earth.
C) The observation was interesting but had no other particular significance.
D) The observation showed that Jupiter must orbit the Sun, not Earth.

Ans: B
Section: 2-6

One of the major contributions of Galileo Galilei to the development of modern astronomy was:
A) use of parallax to prove that Earth moves around the Sun.
B) proof that planetary orbits are ellipses.
C) development of the first mathematical heliocentric model of the solar system.
D) discovery of the satellites (moons) of Jupiter.

Ans: D
Section: 2-6

What did Galileo see when he observed Jupiter through his telescope? A) nothing interesting because Jupiter is perpetually cloud-covered
B) a set of rings
C) four satellites (moons) orbiting Jupiter
D) phases like the Moon's

Ans: C

Section:  2-6

What was the MOST important difference between the development of Isaac Newton's theory of planetary motion and that of Johannes Kepler?
A) Newton developed his theory from basic physical assumptions, whereas Kepler simply adjusted his theory to fit the data.
B) Newton lived in England, which is famous for clear skies, whereas Kepler lived on the continent, which is notorious for bad weather.
C) Newton based his theory on accurate telescopic observations, whereas Kepler used observations made by eye.
D) Newton lived in a freer political climate, whereas Kepler risked house arrest if his theory opposed the Bible or Aristotle.

Ans: A
Section:  2-7

What was the MOST important contribution of Newton to the development of astronomy?
A) Newton showed that astronomical phenomena can be explained using only basic physics and mathematics.
B) Newton showed that planetary orbits are ellipses, with each planet moving fastest when closest to the Sun.
C) Newton was the first person to observe the sky through a telescope.
D) Newton invented the reflecting telescope.

Ans: A
Section:  2-7

265. Why were Newton's three laws so important to astronomy?
Newton's laws showed that acceleration always results from a change in velocity.
Newton's laws showed why objects released from rest always fall to the ground.
Newton's laws showed that planets can move around the Sun by themselves forever, without coming to rest.
Newton's laws provided a physical basis that did not conflict with the Bible, Aristotle, or Plato.

Ans:  C

Section: 2-7

266. According to Newton's first law:
if no net force is acting on an object, then both the object's speed and direction of travel will be constant.
the larger the rate of change of speed of an object, the larger the force acting upon the object.
an applied force always causes a change in the speed of an object.
an applied force always causes a change in the direction of travel of an object.

Ans: A
Section: 2-7

In which direction would Earth move if the Sun's gravitational force were suddenly removed from it?
A) in a straight line toward the Sun
B) in a circular orbit around the Sun because of its spin
C) in a straight line directly away from the Sun
D) in a straight line along a tangent to its circular orbit

Ans: D
Section: 2-7

What path would a planet (like Earth!) take if the force of gravity from the Sun were to suddenly be removed?
A) The planet would move in a straight line tangential to its present orbit.
B) The planet would stop moving altogether because there would be no gravity acting on it.
C) The planet would move in a straight line outward, directly away from the Sun's position.
D) The planet would begin to move in a long ellipse with the Sun at one focus.

Ans: A
Section: 2-7

How many forces need to be applied to a body in space to keep it moving with a constant velocity?
A) none
B) one force, in a direction opposite to the direction of motion
C) two unequal forces
D) one force, in the direction of motion

Ans: A
Section: 2-7

To specify an object's velocity completely, we need to specify its: A) direction of travel.
B) speed.
C) rate of change of acceleration.
D) speed and direction of travel.

Ans: D
Section: 2-7

To specify an object's velocity, we need to specify: A) how fast it is moving and also its mass.
B) only how fast it is moving.
C) only in which direction it is moving.
D) how fast it is moving and also in which direction it is moving.

Ans: D
Section: 2-7

The careful description of the velocity of a moving object at a particular time requires that one define the:
A) speed and acceleration of the object.
B) speed and direction of the moving object.
C) mass, speed, and position of the object.
D) speed (only) of the object.

Ans: B

Section: 2-7

A body whose velocity is constant: A)
can have any non-zero acceleration. B)
has a positive acceleration.
C) has zero acceleration.
D) has a negative acceleration.

Ans: C
Section: 2-7

The acceleration of an object is defined as the rate of change of its: A)
speed.
B) velocity.
C) direction of travel.
D) position.

Ans: B
Section: 2-7

The acceleration of a moving body is defined as the rate of change of: A)
mass with time.
B) kinetic energy with time.
C) position with time.
D) velocity with time.

Ans: D
Section: 2-7

The acceleration of a body is defined as its rate of change of: A)
weight.
B) velocity.
C) position.
D) mass.

Ans: B
Section: 2-7

You throw a ball straight up in the air. At its highest point, the ball's: A) velocity and acceleration are both zero.
B) velocity is not zero, but its acceleration is zero.
C) acceleration is not zero, but its velocity is zero.
D) velocity and acceleration are both non-zero.

Ans: C
Section: 2-7

A certain object in space is accelerating. From this, we know for certain that its speed:
A) or its direction of travel is changing, or possibly both.
B) is changing.
C) and its direction of travel are both changing.
D) or its direction of travel is changing, but not both.

Ans: A
Section: 2-7

279. Which of the following four objects or persons is NOT accelerating?
a bicyclist gradually slowing down on a straight road while coasting toward a stop sign
a motorcyclist traveling around a circular racetrack at a constant speed
an apple falling to the ground from an apple tree
an Olympic swimmer exerting considerable force to maintain a constant speed in a straight line through the water

Ans: D
Section: 2-7

A force can give a certain mass a certain acceleration. If you double the force and double the mass, the acceleration of this object will be:
A) one-quarter of the original acceleration.
B) one-half the original acceleration.
C) the same as the original acceleration.
D) twice the original acceleration.

Ans: C
Section: 2-7

A feather and a boulder will have equal accelerations when falling under the influence of gravity in a vacuum because:
A) the ratio of the object's weight to its mass is the same.
B) gravity does not act in a vacuum.
C) the gravitational force on each object is the same.
D) all gravitational accelerations everywhere are equal.

Ans: A
Section: 2-7

282. Newton's second law states that:
force equals mass divided by acceleration.
force equals mass times acceleration.
weight equals force times acceleration.
acceleration equals force times mass.

Ans: B
Section: 2-7

283. Newton's second law of motion states that:
a force is always required to keep an object in motion.
a body acted on by a net force will accelerate constantly while the force is applied.
objects orbiting the Sun always move in elliptical orbits.
a body acted on by a force will move at a constant speed while the force is applied.

Ans: B
Section: 2-7 and 2-8

According to Newton's second law of motion, an object acted on by a constant force:
A) always moves with a constant velocity.
B) always moves with a constant acceleration.
C) does not move.
D) always moves with a constant speed, although the direction may vary.

Ans: B
Section: 2-7

According to Newton's laws, a force must be acting whenever: A) an object moves with some speed.
B) the direction of an object's motion changes.
C) time passes.
D) an object's position changes.

Ans: B
Section: 2-7

Two spaceships that have different masses but rocket engines of identical force are at rest in space. If they fire their rockets at the same time, which ship will speed up faster?
A) the ship with least mass B) the ship with greatest mass
C) The spaceships will increase speed at the same rate because they have identical rocket engines.
D) The spaceships will not speed up at all; they will move at a constant speed because they are in space and the rocket has nothing against which to push.

Ans: A
Section: 2-7

287. How many forces need to be applied to a body in space to keep it moving with a

constant velocity?
one force, in the direction of motion
none
two unequal forces
one force, in a direction opposite the direction of motion

Ans: B
Section: 2-7

Newton stated that a constant force, continuously applied to a body in space, will give it a:
A) constant acceleration.
B) change of position from one state of rest to another state of rest.
C) constant velocity.
D) headache.

Ans: A
Section: 2-7

Newton stated that if a force were applied to an object in space, the resultant acceleration would depend on the:
A) initial position of the object.
B) size of the object.
C) initial speed of the object.
D) mass of the object.

Ans: D
Section: 2-7

An unbalanced force acting on an object will always cause it to change its: A) direction of travel.
B) speed or direction of travel or both.
C) acceleration.
D) speed.

Ans: B
Section: 2-7

Which of the following descriptions characterizes the Newtonian understanding of the mechanics of the solar system?
A) The natural motion of the planets is motion in a straight line. The planets are prevented from straight-line motion by the gravitational force of the Sun.
B) The natural motion of the planets is uniform circular motion. The gravitational force of the Sun distorts the orbits of the planets into ellipses.
C) The planets are held in their orbits by a gravitational balance between the Sun (which is closer) and the stars (which are farther away).
D) The planets are held in their orbits by a balance between gravitation (attraction) and magnetism (repulsion).

Ans: A
Section: 2-7

The Sun exerts a gravitational pull on Earth. Why doesn't Earth fall into the Sun? A) Earth is moving across the Earth-Sun direction, so Earth is pulled around in a circle. B) Earth also exerts a gravitational pull on the Sun that is equal and opposite to the pull it feels from the Sun.
C) Earth and the Sun are kept apart by the interactions of their magnetic fields.
D) Retrograde motion counteracts the gravitational pull and keeps Earth from falling into the Sun.

Ans: A
Section: 2-7

An object orbiting the Sun in a circle can be said to be: A)
moving at a constant velocity.
B) weightless.
C) moving under the action of equal and opposite forces.
D) always accelerating.

Ans: D
Section: 2-7

Which of the following statements about an asteroid moving in a circular orbit around the Sun is NOT true?
A) An asteroid moving in a circular orbit around the Sun is moving at a constant speed.
B) An asteroid moving in a circular orbit around the Sun is moving in a flat plane.
C) An asteroid moving in a circular orbit around the Sun is accelerating.
D) An asteroid moving in a circular orbit around the Sun is moving at a constant velocity.

Ans: D
Section: 2-7

An accelerating body must at all times: A)
have an increasing velocity.
B) be moving.
C) have a changing direction of motion.
D) have a changing velocity.

Ans: D
Section: 2-7

Which of the following statements is a CORRECT version of Newton's third law? A) Whenever some object A exerts a force on some other object B, B must exert a force of equal magnitude on A in the same direction.
B) Whenever some object A exerts a force on some other object B, B must exert a force of equal magnitude on A in the opposite direction.
C) Whenever two forces act, they must be equal in magnitude and opposite in direction.
D) Whenever any object feels some force, it must also feel another force of equal magnitude in the opposite direction from some other source.

Ans: B
Section: 2-7

297. According to Newton's third law, if a force is acting on an object, then:
there must be some other force acting on a different object, with the same magnitude but in the opposite direction.
the object must move in a circular path.

there must be some other force also acting on the object, with the same magnitude but in the opposite direction.
the object must accelerate.

Ans: A
Section: 2-7

Which of the following pairs of forces is an example of an action-reaction pair by Newton’s third law?
A) for a dog pulling on its leash, the force of the dog on the leash and the force of the leash on the dog
B) for a baseball player sliding into first base, the force of the baseball player on his shoes and the friction force of the ground on his shoes
C) for a tugboat pulling a barge, the force of the water on the barge and the force of the barge on the tugboat
D) for the solar system, the force of the Sun on Earth and the force of the Sun on Mars

Ans: A
Section: 2-7

A horse is dragging a loaded sled across a field. Which of the following pairs of forces is an action-reaction pair by Newton’s third law?
A) the force of the horse on the sled and the force of the ground on the sled
B) the force of the horse on the sled and the force of the sled on the horse C)
the force of the horse on the sled and the force of the ground on the horse
D) the force of the sled on the ground and the force of the horse’s hooves on the ground

Ans: B
Section: 2-7

A diver weighing 138 pounds has just dived up and out from the high board and is doing a back flip before starting to descend toward the water. How much force does the diver exert on Earth while doing the back flip?
A) much more than 138 pounds because Earth is so much more massive than the diver
B) zero
C) much less than 138 pounds (but more than zero) because the diver has so much less mass than Earth

D)  138 pounds

Ans: D
Section:  2-7

The old story about the person who sneezed so hard that he fell off his barstool is an exaggerated illustration of which physical law?
A) Newton's law of universal gravitation
B) the law forbidding the partaking of alcohol during physical experiments
C) Newton's third law of equal and opposite forces of action and reaction
D) the law of inertia, Newton's first law

Ans: C
Section:  2-7

What is the size of the force you exert on Earth compared with the force Earth exerts on you as you stand on its surface?
A) zero because you do not exert a force on Earth
B) very small because your mass is small compared with that of Earth
C) twice as large because of Earth's rotation
D) the same

Ans: D
Section:  2-7

A person standing on bathroom scales sees a reading of 148 pounds. This person is acted on by:
A) no forces at all.
B) only one force (148 pounds, as shown by the reading on the scales).
C) only one force of 296 pounds (the sum of 148 pounds from Earth and 148 pounds from the scale).
D) two forces of equal size acting in opposite directions.

Ans: D
Section:  2-7

A rocket that is accelerated by the force from the ejection of large quantities of hot gases represents an example of which physical law originally stated by Newton?
A) Newton's law of elliptical motion of planets
B) Newton's law of universal gravitation
C) Newton's first law of motion, concerned with state of rest or uniform motion
D) Newton's third law of motion, concerning action and reaction forces

Ans: D
Section: 2-7

The action and reaction forces referred to in Newton's third law of motion: A)
act on the same body.
B) must be equal in magnitude but need not act in the same straight line.
C) need not be equal in magnitude but must act in the same straight line.
D) act on different bodies.

Ans: D
Section: 2-7

The strength of gravity on Mars is about 40% of that on Earth. If you were to take a standard red brick to Mars, which property of the brick would be significantly different on Mars than on Earth?
A) mass
B) color
C) volume
D) weight

Ans: D
Section: 2-7

The strength of gravity on Mars is about 40% of that on Earth. If your mass on Earth is 60 kg, what would your MASS be on Mars?
A) 150 kg
B) zero C)
24 kg

D)  60 kg

Ans: D
Section:  2-7

The strength of gravity on Mars is about 40% of that on Earth. If your mass on Earth is 60 kg, what would your WEIGHT be on Mars?
A) 24 kg
B) 24 newtons
C) 235 newtons
D) 588 newtons

Ans: D
Section:  2-7

The strength of gravity on Mars is about 40% of that on Earth. If you were to visit Mars, what would happen to your mass and weight compared with when you were on Earth?
A) Your weight would be the same, but your mass would be less.
B) Your weight and mass would both be less than when you were on Earth.
C) Your weight and mass would both be unchanged from when you were on Earth.
D) Your mass would be the same, but your weight would be less.

Ans: D
Section:  2-7

Compared with your mass on Earth, your mass out in space among the stars would be:
A) negligibly small.
B) the same.
C) zero.
D) huge.

Ans: B
Section:  2-7

On the Moon, where gravity is 1/6 of Earth's gravity, which of the following activities would an astronaut NOT find easier to carry out?
A) high jumping
B) running
C) long jumping
D) slowing down and stopping

Ans: D
Section: 2-7

I have a massive purple object in my laboratory. If I were to take it to the Moon, which of its characteristics would be guaranteed to change?
A) weight
B) color
C) density (mass per unit volume)
D) mass

Ans: A
Section: 2-7

Two solid spheres of equal size and mass are joined by a spring-loaded, extendible rod. The whole unit is spinning like a baton (end-over-end) five times per second. Suddenly, the rod stretches, pushing the spheres farther apart. What change takes place as a result of the stretching?
A) The angular momentum of the spheres and rod decreases.
B) The angular momentum of the spheres and rod increases.
C) The rate of spin of the spheres and rod decreases.
D) The rate of spin of the spheres and rod increases.

Ans: C
Section: 2-7

The angular momentum of an object depends ONLY on: A)
the mass of the object and how fast it is spinning.
B) the mass of the object, how the mass is distributed, how fast the object is spinning,

and how strong a gravitational field the object is in.
how fast the object is spinning.
the mass of the object, how the mass is distributed, and how fast the object is spinning.

Ans: A
Section: 2-7

For the angular momentum of an object to be conserved (i.e., to not change), the: A) speed of the object must not change.
B) object must not be acted on by an internal torque (caused, for example, by the muscles in a skater's arms).
C) object must not be acted on by an outside torque.
D) size of the object must not change.

Ans: C
Section: 2-7

Which concept in Newton's mechanics provides an answer to the question: Why don't the planets fall into the Sun?
A) conservation of energy
B) conservation of mass
C) conservation of momentum
D) conservation of angular momentum

Ans: D
Section: 2-7

If you travel from Earth to the Moon, which of the following quantities will be unchanged?
A) the gravitational force acting on you
B) your mass
C) your weight in pounds
D) your weight in Newtons

Ans: B
Section: 2-7

Was Newton's *derived* version of Kepler's third law the same as the version Kepler discovered by trial and error?
A) Yes, it was.
B) No, Kepler included the effect of the planet's mass, whereas Newton did not.
C) No, Newton included the effect of the planet's mass, whereas Kepler did not.
D) No, Kepler's equation applied only to the inner planets, whereas Newton's applied to all the planets.

Ans: C
Section: 2-8

A gravitational force is exerted by a large mass on a small mass a certain distance away. If I increase the separation to three times its original value and then switch the large and small masses, what will happen to the gravitational force?
A) It will remain the same.
B) It will increase by a factor of three.
C) It will decrease by a factor of three.
D) It will decrease by a factor of nine.

Ans: D
Section: 2-8

If two massive bodies, initially held at rest in space, are released, then they will begin to:
A) move away from each other with constant acceleration.
B) move toward one another.
C) move in elliptical orbits around each other.
D) orbit one another in circles.

Ans: B
Section: 2-8

Suppose two asteroids are located at the same distance from the Sun. One asteroid has twice the mass of the other. According to Newton's law of gravitation (and ignoring all forces except that from the Sun):

the more massive asteroid feels half the force that the other does.
the more massive asteroid feels twice the force that the other does.
neither feels any force because they are weightless in space.
both asteroids feel the same force because gravity acts equally on all objects.

Ans: B
Section: 2-8

How much gravitational force acts on an astronaut in the space shuttle in a circular orbit 300 km above Earth's surface?
A) almost zero, but not quite
B) exactly the same as when the astronaut is standing on the surface of Earth
C) zero, because the astronaut is weightless
D) almost (but not quite) as much as when the astronaut is standing on the surface of Earth

Ans: D
Section: 2-8

323. A person orbiting Earth in the space shuttle feels weightless because:
two forces are acting on her in opposite directions, so they cancel and produce the same effect as if no force at all were acting.
her mass is zero in space, and weight requires mass.
no forces act on her.
only one force (gravity) acts on her, but gravity also accelerates the Shuttle, so the Shuttle does not push up on her to create the feeling of weight.

Ans: D
Section: 2-8

The International Space Station is in orbit around Earth. If an astronaut aboard the station releases an object in mid-air, it will:
A) remain at rest because no gravitational force acts on it.
B) be pulled by gravity in orbit around Earth along with the rest of the Space Station.
C) drop to the floor of the Space Station, just as it would on Earth.
D) accelerate toward the ceiling of the Space Station because of the absence of gravity.

Ans: B
Section: 2-8

The first person to derive the elliptical shape of planetary orbits from basic physics and mathematics (not from observations of planetary positions) was:
A) Kepler.
B) Galileo.
C) Newton.
D) Copernicus.

Ans: C
Section: 2-8

Who was the discoverer of the planet Uranus? A)
Galileo Galilei, in 1610
B) Johann Galle, in 1846
C) Clyde Tombaugh, in 1930
D) William Herschel, in 1781

Ans: D
Section: 2-8

327. How was the planet Uranus discovered?
Uranus was discovered accidentally during a telescopic survey of the sky.
Uranus was discovered by mathematical prediction using Newton’s laws.
Uranus happened to pass close to Jupiter in the sky and was discovered by an astronomer studying Jupiter.
No one knows—Uranus has been known since ancient times.

Ans: A
Section: 2-8

328. How was the planet Neptune discovered?
A) Neptune was discovered by mathematical prediction using Newton’s laws.

Neptune happened to pass close to Jupiter in the sky and was discovered by an astronomer studying Jupiter.
Neptune was discovered accidentally during a telescopic survey of the sky.
No one knows—Neptune has been known since ancient times.

Ans: A
Section: 2-8

Which object was discovered mathematically using Newton's laws before it was discovered observationally through the telescope?
A) Pluto B)
Mercury C)
Neptune D)
Uranus

Ans: C
Section: 2-8

Which object was discovered after its position had been predicted by the application of Newtonian mechanics to the deviation in the motion of another planet?
A) minor planet Ceres
B) Uranus
C) Neptune
D) Pluto

Ans: C
Section: 2-8

In the years after Newton published his laws of motion, it was found that the observed positions of the planet Uranus did not match the predictions of Newton's theory. The reason for this turned out to be the:
A) perturbing effects of Jupiter and Saturn, whose masses at that time were not accurately known.
B) perturbing effect of Neptune, which at that time had not yet been discovered.
C) perturbing effect of Pluto, which at that time had not yet been discovered. D) weakening of gravity with increasing distance from the Sun.

Ans: B
Section: 2-8

In the years after Newton published his laws of motion, it was found that the observed positions of the planet Uranus did not match the predictions of Newton's theory. The reason for this turned out to be:
A) the gravitational influence of a previously unknown planet.
B) the perturbing effects of previously unknown satellites (moons) of Uranus.
C) inaccuracies in the observations.
D) inaccuracies in Newton's laws (later corrected by general relativity).

Ans: A
Section: 2-8

Who predicted the existence of the planet Neptune before it was discovered observationally?
A) Kepler and Brahe B)
Newton and Halley C)
Adams and Leverrier D)
Kepler and Galileo

Ans: C
Section: 2-8

The first major astronomical prediction of Newton's theory of gravitation to be confirmed by observation was the:
A) return of Halley's Comet.
B) supernova of 1572.
C) discovery of Pluto. D)
discovery of Neptune.

Ans: A
Section: 2-8

Suppose that an object is discovered moving around the Sun once every 120 years. Which of the following paths is a possible orbit for this object?
A) a straight line
B) a parabola C)
an ellipse D) a
hyperbola

Ans: C
Section: 2-8

An object is in an orbit caused by its gravitational attraction to the Sun. This orbit: A) must be an ellipse.
B) must be a parabola.
C) must be a hyperbola.
D) might be an ellipse, a parabola, or a hyperbola.

Ans: D
Section: 2-8

Which of the following situations describes an acceptable path for a body gravitationally bound to the Sun?
A) a parabolic path passing through the center of the Sun
B) a circular path with the Sun on the circle
C) a long ellipse, with the Sun at one focus
D) a long ellipse, with the Sun at its center

Ans: C
Section: 2-8

Which objects are often found to follow hyperbolic orbits? A)
small satellites of the outer planets
B) asteroids
C) None—all orbits have to be ellipses.
D) comets

Ans: D
Section: 2-8

What happens to objects that acquire enough energy to transition to hyperbolic orbits within the solar system?
A) They make only a single pass near the Sun and then leave the solar system forever.
B) They remain in stable hyperbolic orbits, but on the outer edge of the solar system.
C) They gain energy and transition to parabolic orbits.
D) They always crash into the Sun.

Ans: A
Section: 2-8

The effect of the gravitational force only extends as far as: A) Earth’s atmosphere.
B) the edge of the solar system.
C) the edge of the Milky Way Galaxy.
D) the full extent of the universe.

Ans: D
Section: 2-8

Which objects are often found to follow parabolic orbits? A) small satellites of the outer planets
B) asteroids
C) None—all orbits have to be ellipses.
D) comets

Ans: D
Section: 2-8

342. What is a hyperbola?
a straight line extending to infinity in one direction
a long, skinny ellipse
an infinitely long curve that never closes on itself
an ellipse with equal major and minor axes

Ans: C
Section: 2-8

In which order (from earliest to latest) did the following people make their major contributions to astronomy?
A) Brahe, Copernicus, Newton, Kepler
B) Copernicus, Brahe, Kepler, Newton
C) Copernicus, Kepler, Brahe, Newton
D) Kepler, Copernicus, Brahe, Newton

Ans: B
Section: Chapter 2