

## Exam 3 Review Solutions

**Note:** Solutions for all of the quiz questions are given. Not all of the solutions for non-quiz questions are given.

### Chapter 10 (Lectures 17 and 18)

**3q. A fundamental process that shaped the Moon's surface was**

(a) impacts of asteroidal debris onto a hard, immobile crust.

**4q. Over geologic time, plate tectonics has been the dominant process shaping the surface of the Earth. In comparison, what plate tectonic features do we see on the surface of the Moon?**

(b) None at all.

**5q. The Moon's surface appears to be split into two distinct hemispheres, one containing numerous dark circular basins or maria, the other consisting mainly of light-colored highlands and only one small mare. Which segment of the Earth's population has seen this latter hemisphere?**

(a) Only the Apollo astronauts.

**6q. The majority of the craters on the Moon were caused by**

(a) impact of meteoritic material upon the surface.

**7q. How do we know the lunar maria (or "seas") are younger than the lunar highlands?**

(a) The maria have relatively few craters, whereas the highlands are very densely cratered from long exposure to

**8q. Most of the mountains on the Moon are**

(a) the raised rims of ancient impact craters and maria.

**11q. Evidence for water on the Moon has recently been discovered in the form of**

(a) ice, in deep craters at the north and south poles, perpetually shaded from sunlight.

**12q. What have we learned about the Moon's global magnetic field?**

(a) The Moon has no global magnetic field at the present time, but did have early in its life.

**14q. How does the lunar lithosphere (the crust and solid, outer part of the mantle) compare to that of the Earth?**

(c) The lunar lithosphere is eight or more times thicker than that of the Earth.

**15q. Compared to earthquakes on Earth, moonquakes are**

(c) much less frequent and far less intense.

**16q. Moonquakes appear to be more frequent**

(a) when the Moon is near perigee (closest to the Earth).

**19q. The ages of lunar rocks, brought back to Earth by astronauts and robotic spacecraft, have been determined by**

(b) the measurement of relative radioactive element concentrations.

**21q. What has happened to the rate of impact cratering on the Moon over the Moon's history?**

(a) It tapered off very quickly from a high value when the Moon first formed to a very low cratering rate less than a billion years later, remaining very low ever since.

**22q. During what part of the geological history of the Moon did the lava flows occur that we now see as the lunar maria?**

(b) Between 3.8 and 3.1 billion years ago, at or just after the end of the heavy bombardment phase.

**25q. The origin of the Moon in the early history of the solar system appears to have been**

(b) the ejection of debris from a collision of a planet-sized object with the Earth, and subsequent coalescence into the Moon.

**1b. The terminator on the Moon is a line**

C) between the solar-illuminated and dark hemispheres.

**2b. The diameter of the Moon is**

C) about 1/4 of the diameter of the Earth.

**3b. People on Earth see**

B) the same side of the Moon at all times.

**4b. To observers on Earth, the Moon shows**

C) only one side to Earth at all times.

**6b. The rotation period of the Moon on its axis with respect to space (its absolute rotation) is**

B) 27.3 days, the sidereal revolution period.

**7b. If viewed from a point directly above the plane of the planetary system, how would the Moon appear to rotate on its axis?**

D) It would rotate once per month, or once per revolution about Earth.

**10b. Which of the following general statements about the Moon is true?**

A) There is one side of the Moon from which Earth can never be seen.

**11b. If you were standing on the Moon with Earth in view, how much time would elapse between two successive "Earthrises"?**

**15b. If astronauts set up a permanent settlement at Tranquility Base on the Moon, how many times each year would the Sun rise and set as seen by a resident of this base?**

**16b. Astronauts at a Moon base visible from Earth will NOT see**

**28b. What are the most common shapes of lunar craters and why?**

**29b. Maria are**

D) ancient lava floodplains.

**30b. Maria are**

A) large impact craters in-filled by lava.

**31b. A mare on the Moon is a**

C) large area of dark material on the lunar surface.

**51b. The impact craters on Earth are younger than a few million years old, whereas ages of lunar craters extend back billions of years. Why is this?**

**124b. Before the Mars-sized impactor struck the Earth to cause ejecta which formed the Moon, the Earth probably had a**

A) smaller density and slower rotation rate than it does now.

**125b. Which of the following is believed to be the correct explanation for the origin of the Moon?**

D) The Earth was struck by a large planetesimal, which caused material to be ejected. This material

coalesced to form the Moon.

**121b. Which one of the following four theories about the origin of the Moon is now believed to be correct?**

A) An object about the size of Mars crashed into Earth and debris from the collision formed the Moon.

**119b. Although we do not yet know precisely how the Moon was formed, an important clue is provided by the fact that**

C) moon rocks resemble rocks close to the surface of Earth.

**118b. The theory that seems to account most satisfactorily for the origin of the Moon at the present time is that**

B) a large object collided with Earth and ejected the material that formed the Moon.

**116b. One theory about the origin of the Moon says that the Moon was formed from debris thrown out when a Mars-sized object collided with Earth. One fact that strongly supports this theory is that**

D) Moon rocks are very similar to those of Earth but are depleted in elements that melt at relatively low temperatures.

**1class. Figure 1 shows the rate of crater-making impacts as a function of time. If at 2 billion years ago the rate of crater-making impacts started to increase again, what would be different about how the moon looked?**

**2class. When is the far side of the moon the same as and the dark side of the moon?**

(c) Once per month

**3class. What is the fission theory of the formation of the moon?**

(c) The theory that the moon was created when a chunk of Earth tore off and started orbiting.

**4class. What is synchronous motion?**

### Chapter 11 (Lecture 18)

**1q. A colleague tells you that she was outside at midnight and saw Mercury at opposition in the southern sky, from her position in the northern hemisphere. Do you have any reason to question this statement?**

B) Yes. Because Mercury never reaches the position of opposition and can never be seen at midnight.

**2q. Mercury's surface**

C) has a very low albedo, reflecting very little sunlight.

**3q. Mercury has an albedo of only 12%, which means that it reflects only this percentage of sunlight falling on it. Why then does Mercury appear to be among the brightest objects in our sky?**

C) Because it is close to the Sun and the Sun shines very intensely on it.

Section 11-2

**8q. The difference in temperatures between the illuminated and dark sides of Mercury is**

A) extreme because of Mercury's specific rotational period and the lack of an atmosphere.

**9q. The temperature on the dark side of Mercury is warmer than would be expected if that side of Mercury always faced away from the Sun. The reason for this is that**

B) Mercury rotates about its own axis in a shorter time than it revolves around the Sun, so all parts of Mercury face the Sun at some time during each orbit.

**14q. Mercury looks very similar to which planet or satellite in our solar system?**

C) Our Moon because of all the craters.

**1b. Mercury can be characterized as having**

A) a Moon-like surface and an Earth-like interior.

**3b. When Mercury is at its greatest western elongation, it is seen to the**

B) west of the Sun in our predawn sky.

**4b. Mercury can be seen most easily from Earth**

A) near the Sun, just after sunset or just before sunrise.

**5b. A friend who says that he is an astronomer claims that he was outside at midnight a few weeks ago**

**looking at Mercury. What should be your response?**

B) "You must be mistaken, because Mercury NEVER appears in our midnight sky."

**6b. It is relatively difficult to observe details on the surface of Mercury from Earth because**

C) it is a small object that always appears close to the Sun in the sky.

**12b. How often does a solar transit of Mercury—Mercury passing directly across the face of the Sun as seen from Earth—occur?**

D) relatively infrequently—between 10 and 20 times per century

**23b. How many times will Mercury rotate with respect to the Sun in one sidereal orbital period?**

**33b. To what does the phrase "synchronous rotation" for an astronomical object (e.g., planet or moon) refer?**

C) It completes precisely one rotation around its own axis for every orbit (1-1 spin-orbit coupling).

**34b. What method first showed that Mercury does not rotate synchronously (one rotation about its own axis for every orbit around the Sun)?**

**35b. The reason the temperature on the dark side of Mercury is warmer than originally expected is that**

B) Mercury does not rotate synchronously with its orbital period.

**39b. If you are on Mercury and the time is noon (Sun directly overhead), what time of day will it be one**

**Mercurian year later (after Mercury has orbited the Sun once)?**

**43b. Suppose Mercury had 5-to-3 spin-orbit coupling and that its sidereal period remained 88 days, as it is now. What would be the time from noon to noon on Mercury, in days?**

C) 264

**44b. Suppose Mercury had 5-to-3 spin-orbit coupling and that its sidereal period remained 88 days, as it is now. You observe the Sun directly overhead in the Mercurian sky and then observe again from the same location 88 days later. Where will the Sun be in the sky? (Mercury, like Earth, rotates toward the east.)**

A) below the eastern horizon

**48b. Which planet most resembles the Moon in visible surface features and atmosphere?**

B) Mercury

**54b. What is believed to be the cause of the long, meandering scarps (cliffs) observed on Mercury?**

A) shrinkage of the planet as Mercury cooled

**79b. Mercury's magnetic field, compared with that of Earth, is**

B) weak, but strong enough to deflect the solar wind.

**80b. The magnetic field of Mercury appears to be caused by**

D) electric currents in a molten iron core.

**82b. Two conditions appear to be necessary for the generation of a powerful magnetic field in planets that are not present simultaneously on Mercury. These conditions are**

A) rapid rotation and a molten iron core.

**1c. In Figure 1, which wave has the longest wavelength?**

A) A

**2c. In Figure 1, which wave has the highest frequency?**

C) C

**3c. If Mercury were rotating clockwise in Figure 1, how would the waves change?**

**4c. If Mercury was struck by an asteroid that caused it to suddenly start moving to the right, how would the waves change?**

D) A, B, and C would have an increased wavelength

**5c. If a planet rotates around the Sun in 200 days, what is its orbital period?**

C) 200 days

**6c. If a planet rotates on its axis with respect to the stars once every 100 days, what is its rotational period?**

B) 100 days

**7c. If the planet shown in Figure 2 has an orbital period of 100 days and a rotational period of 50 days, how long is the length of its day?**

B) 100 days

**8c. If the planet shown in Figure 2 has an orbital period of 100 days and a rotational period of 10000 days, where will the arrow be pointing after 100 days?**

**Chapter 12 (Lecture 19)**

**1q. Venus appears to be very bright in our sky at certain times because**

(c) it is covered in reflective clouds and is relatively close to the Sun.

**2q. The planet Venus is often referred to as the Earth's twin planet. Which physical property of Venus is similar to that of the Earth?**

(b) Its diameter.

**3q. How were astronomers first able to measure the rotation period of Venus (i.e., the length of a Venusian day)?**

(b) They sent microwaves to Venus from Earth-based radio telescopes and measured the Doppler shifts in the reflected signals.

**4q. What is distinctive about the rotation of Venus about its axis?**

(a) It rotates in an inverse direction to that of most of the planets, and to the orbital revolution direction of the planets.

**5q. What is believed to be the most likely explanation for why Venus rotates backward (retrograde) compared to most of the other planets and compared to its orbital motion?**

(c) It was caused by interactions between the Sun and Venus's atmosphere. Tidal friction between the atmosphere and the surface slowed Venus's rotation, and then solar-induced winds started Venus rotating in the opposite direction.

**6q. Which of the following statements best describes the planet Venus?**

(c) Perpetual clouds, high surface temperatures, and light cratering.

**7q. The extremely high surface temperatures on Venus were first measured using**

(a) the shape and peak wavelength of the black-body continuum radiation in the visible spectral range.

**9q. The key gas on Venus that is responsible for the greenhouse effect, the buildup of high temperatures in its lower atmosphere, is**

(a) CO<sub>2</sub>, carbon dioxide.

**10q. The so-called greenhouse effect, which produces very high temperatures on the surface of Venus, is**

(a) the absorption by the CO<sub>2</sub> gas of the planet's atmosphere of infrared radiation emitted by the (b) hot planet surface, which itself is heated by sunlight.

**11q. Compared to the Earth's atmosphere, that of Venus has**

(b) much higher atmospheric pressure (100 atmospheres) and temperature (750 K).

**12q. The temperature in the atmosphere of Venus decreases smoothly with increasing altitude all the way from the surface (hottest) to the outermost parts of the atmosphere (coolest). What does this observation tell us about the atmosphere of Venus? (Hint: Think about why the temperature in the Earth's atmosphere differs from this.)**

(b) Venus has essentially no ozone in its atmosphere.

**13q. What interesting result do spacecraft measurements show about sulfur on the planet Venus?**

(c) Sulfur is an important component of Venus's atmosphere, producing sulfuric acid in the clouds and fluorosulfuric acid on the surface.

**22q. If Venus had an atmosphere of about the same density as the Earth's and no greenhouse effect, what would be the probability of life existing on its surface?**

(c) Essentially zero.

**23q. The reason that Venus has no magnetic field, even though it is similar in size to Earth, and appears to have a molten core, is**

(c) that it rotates very slowly, and this rotation is insufficient to drive the internal magnetic dynamo.

**27q. The reason why Venus's surface is only lightly cratered appears to be that**

(c) lava flows have covered over most of the early cratering, and there has been little recent cratering.

**1b. Which of the planets fits the following description: "a hot solid surface, cloud-shrouded, with a dense CO<sub>2</sub> atmosphere"?**

A) Venus

**4b. Venus appears to be very bright in our skies at certain times because**

D) it is relatively close to the Sun, Earth is close to it, and it is covered by very reflective clouds.

**7b. Why are there are so few solar transits of Venus across the Sun's face as it revolves in its orbit and passes through inferior conjunction?**

**8b. On the basis of appearance and general properties, which planetary body could be described as Earth's twin?**

B) Venus—about the same mass and diameter, with a dense and cloud-shrouded atmosphere

**15b. Venus rotates in**

D) the opposite direction to Earth but very slowly.

**21b. The length of one solar day (i.e., time between successive sunrises) on Venus is**

B) much longer than that on Earth.

**26b. The component of Venus's atmosphere that is responsible for the greenhouse effect, or excess heating, is**

**31b. The main reason for the very high temperature (750 K) on the surface of the planet Venus is thought to be**

D) the absorption of visible radiation by the surface and clouds and the trapping of re-radiated infrared radiation by the atmosphere.

**32b. The mechanism of the greenhouse effect, which has resulted in very high temperatures on the surface of Venus (and moderate temperatures on Earth), can be described as**

A) solar UV and visible radiation heating the planet surface, the infrared emissions of which are then trapped by CO<sub>2</sub> in the atmosphere.

**34b. Why is the surface of Venus hotter than that of Mercury, even though Mercury is much closer to the Sun?**

**36b. The highest temperature in the atmosphere of Venus occurs**

D) at the planet's surface.

**60b. Which particular chemical associated with volcanic emissions has been detected by various techniques in amounts that appear to vary significantly over short time scales, indicating the presence of active volcanoes on Venus at the present time?**

D) sulfur and sulfur compounds

**63b. Hot-spot volcanism is a process that**

A) produces gigantic volcanoes on Venus and Mars but produces chains of smaller volcanoes on Earth (e.g., the Hawaiian Islands).

**80b. On both Earth and Venus some sulfur dioxide is removed from the atmosphere to be locked up in various rocks and minerals. On Earth this SO<sub>2</sub> is recycled deep beneath the surface to be outgassed by volcanoes and again become part of the atmosphere. On Venus this SO<sub>2</sub> is not recycled. Why this difference?**

B) Venus does not experience the movement of tectonic plates.

**81b. At what point did the greenhouse effect cease to raise the temperature of Venus?**

B) when the radiation from Venus balanced the radiation absorbed by Venus

**90b. Tectonic activity on Venus differs from that on Earth in that**

**1c. What causes the runaway greenhouse effect on Venus?**

(b) Its lack of a way of removing CO<sub>2</sub> from the atmosphere

**2c. Why is the year on Venus longer than that on Mercury?**

(b) Venus is takes longer to orbit the Sun than Mercury.

**3c. Figure 1 is a view of Venus and the Sun from above their north poles. Which way does Venus rotate around the Sun and around its axis?**

(a) CCW around Sun, CW around its axis

**4c. If an observer says it is noon in Figure 1 at point A, what time is it for the observer at point B?**

## Chapter 13 (Lecture 20)

**2q. The length of each of the Martian seasons, compared to those on Earth, is**

(b) about twice as long because of Mars's orbital period.

**3q. What evidence is there for the proposal that at least parts of the Martian surface are very old?**

(a) The observations of craters similar to those on our Moon, which were formed at least 3 billion years ago and have survived until the present time.

**4q. Which of the following descriptions best characterizes the surface of Mars?**

(b) Two distinct hemispheres: volcanoes and volcanic plains in the northern hemisphere and extensive impact cratering in the southern hemisphere.

**5q. The volcanoes of Mars are**

(b) massive, extinct, and solitary structures.

**9q. Which of the following planets or planet-sized objects is most strongly suspected of having abundant water at the present time?**

(b) Mars, one piece of evidence being the persistent white polar caps that survive the heat of summer.

**10q. Evidence for water stored as permafrost under the Martian surface is shown in**

(a) river valleys extending away from obvious impact craters

**11q. The average surface conditions near Mars's north and south poles can best be described as**

(c) cold and icy.

**15q. Which piece of evidence suggests that the Martian North Pole is covered by a layer of water ice in addition to an overlying layer of CO<sub>2</sub> ice?**

(b) The initial disappearance of the white north polar cap is rapid as summer approaches but this is disappearance rate slows significantly at a certain time.

**18q. One major feature of the Martian "climate" is**

(b) major dust storms.

**20q. Ultraviolet radiation from the Sun has played a more important role in Martian surface chemistry than it has on Earth because**

(b) the Mars atmosphere contains no ozone to absorb this energetic radiation.

**2b. Which planet in our solar system fits the following description: "A planet with a large iron core, heavily cratered surface, and no (or almost no) atmosphere"?**

C) Mercury

**3b. Which of the planets fits the following description: "a solid, cool surface, with occasional dust clouds and a thin CO<sub>2</sub> atmosphere"?**

C) Mars

**1b. Which of the planets fits the following description: "A planet with a very hot, solid, cratered surface with no atmosphere"?**

D) Mercury

**6b. During favorable oppositions of Mars, when the planet comes relatively close to Earth, where would Mars be seen in the sky by an observer in the Earth's northern hemisphere?**

A) high in the south at midnight

**8b. Mars is best viewed from Earth when it is at opposition, but some occasions are more favorable than others. Why is this?**

A) Mars has an elliptical orbit, and favorable oppositions occur when Mars is at perihelion in its orbit and hence closest to Earth.

**9b. Assume Earth has a circular orbit with a radius of 1 AU. At its most favorable opposition Mars is 0.37 AU from earth, and at its least favorable opposition it is 0.68 AU from Earth. From these data, what do you calculate as the sidereal period of Mars (in years)?**

C) 1.88

**13b. Prominent but variable ice caps were detected by early observers on which planet?**

B) Mars

**17b. Mars experiences similar seasonal changes to those on Earth because**

B) its spin axis is tilted at about the same angle to its orbital plane as is the Earth's axis.

**18b. The equator of Mars is tilted with respect to its orbital plane and therefore Mars**

**39b. The most important mechanism that transports heat outward from the interiors of Venus and Mars is**

D) hot-spot volcanism, where molten lava flows upward to the surface above hot-spots in the mantle.

**40b. Hot-spot volcanism is a process that**

D) produces gigantic volcanoes on Venus and Mars but produces chains of smaller volcanoes on the Earth.

**55b. On the basis of the surface and atmospheric conditions existing on Mars today, why could there be no liquid water on its surface?**

A) The water would boil and evaporate rapidly under the low atmospheric pressure or freeze to ice at the low surface temperatures.

**57b. Water exists on Mars. Where and in what state does it NOT exist on this planet?**

A) as liquid, flowing in river valleys

**64b. The polar caps on Mars are most likely made up of**

**66b. The initial and very rapid recession of the edge of the white polar cap region toward the poles in springtime is caused by**

**69b. A major feature of the atmosphere of Mars is**

A) occasional strong winds and dust storms.

**77b. The carbon dioxide atmosphere of Mars was much denser in Mars's early history than it is now. What process is now believed to have begun this atmospheric thinning?**

D) The CO<sub>2</sub> was washed out of the atmosphere by rain.

**76b. The greenhouse effect, which heats a planet's surface above the predicted equilibrium surface temperature for the planet without an atmosphere, is far less effective on Mars than on the Earth. Why is this?**

D) The Martian atmosphere is very thin and traps less infrared radiation from the surface.

**108b. On Mars, which of the following features have NOT been seen or detected?**

D) active volcanoes

**120b. The moons of Mars are**

C) irregular in shape and very small, only several tens of kilometers across.

## Chapter 14 (Lecture 21 & 22)

**2q. Jupiter is the largest planet in our solar system. What is Jupiter's mass, compared to that of the rest of the planets?**

(b) Jupiter's mass is a slightly more than two times the mass of all of the other planets combined.

**3q. It is advantageous to observe Jupiter when it is at a position of opposition in its orbital motion because**

(b) it is closest to the Earth at this position.

**4q. The Great Red Spot on Jupiter is**

(b) a large, long-lived anticyclone storm that is maintained by the planet's differential rotation.

**5q. One interesting feature of the motions of the giant planets that distinguishes them from the terrestrial planets is the fact that**

(b) they rotate rapidly

**6q. How does the visual appearance of Saturn compare to that of Jupiter, excluding the differences in the rings?**

(a) Jupiter has an extensive and intricate cloud system of belts, zones, storms, and eddies, whereas Saturn's features appear very subdued and hazy.

**7q. The rotation period of the giant planet Jupiter is**

(b) relatively short, about 10 hours.

**15q. What is believed to be the most important source for the internal heat that Saturn radiates to space?**

(a) Raindrops of liquid helium

**17q. Why do the dark-colored belts on Jupiter appear to be brighter than surrounding regions when observed in infrared or heat radiation?**

(c) Because these are relatively cloud-free regions and we are seeing deeper and hence warmer layers of Jupiter's atmosphere.

**18q. How does the heat radiated into space by Jupiter compare to the amount received from the Sun, and why?**

(c) Jupiter radiates twice as much heat into space as it receives from the Sun because it is still cooling down after the process of planetary formation.

**19q. Why are the colors and patterns in Saturn's atmosphere more muted and harder to see than those in Jupiter's atmosphere?**

(b) Saturn has a thicker layer of haze above its cloud-tops than does Jupiter.

**22q. The cause of the slightly flattened or oblate shape of Jupiter is**

(c) its rapid rotation.

**26q. What is the cause of the immense magnetic field of Jupiter and Saturn?**

(b) Electric currents outside Jupiter's core, deep below the atmosphere.

**27q. What is synchrotron radiation?**

(b) Electromagnetic radiation emitted by charged particles moving in magnetic fields.

**28q. The shape and dimensions of the magnetosphere surrounding Jupiter are controlled by**

(c) the pressure of the ionized gas of the solar wind against the planet's magnetic field.

**30q. The rings of Saturn are in which plane around the planet?**

(c) Saturn's equatorial plane.

**31q. Why do the rings of Saturn appear from the Earth to vary from being very distinct to being almost invisible over a period of a few years?**

(b) The ring structure is very thin and is tilted to the ecliptic plane, making it appear almost edge-on and hence indistinct at certain points in Saturn's orbit.

**35q. At distances inside the Roche limit of a planet,**

(b) differential tidal forces between particles will overcome mutual gravitational attraction.

**36q. Saturn's rings are composed of**

(a) myriads of icy particles, ranging from dust grains to boulders, moving in Keplerian orbits in the planet's equatorial plane.

**37q. Why is it that the icy rocks and particles in the rings of Saturn do not coalesce into larger objects and moons under their mutual self-gravity?**

(b) Because differential tidal forces from the planet overcomes the gravitational attraction at the ring position.

**1b. The mass of Jupiter is 11.25 times that of Earth. What would be the force of gravity exerted by Jupiter on a spacecraft at a distance of 1 AU from Jupiter compared to that exerted on the same spacecraft by Earth at 1 AU from Earth?**

C) 11.25 times as large

**4b. The low average density of Jupiter (about 1300 kg/m<sup>3</sup> compared with that of water, 1000 kg/m<sup>3</sup>)**

**indicates that this planet is composed mainly of**

A) hydrogen, in liquid or gaseous form.

**5b. When viewed from Earth, the apparent angular diameter of Jupiter varies with time because**

**9b. What is the physical appearance of Jupiter as seen from Earth or a spacecraft?**

A) a series of dark belts and light zones parallel to the equator

**12b. One distinctive feature that is visible on the "surface" of Jupiter through a telescope from Earth is**

D) the Great Red Spot.

**14b. The lifetime of the Great Red Spot appears to be**

C) at least 300 years, from visual records.

**20b. For someone standing on the surface of Jupiter, tomorrow's weather forecast is**

D) The question is meaningless, because there is no solid surface on which to stand.

**21b. Evidence of volcanism (lava outflow, etc.), either active or ancient, is NOT found on**

D) Jupiter.

**23b. The rotation periods of Jupiter and Saturn are**

D) relatively short—on the order of 10 hours.

**26b. The interesting feature of Jupiter's rotation is that**

C) regions at different latitudes appear to rotate at different rates.

**32b. Saturn is less massive than Jupiter but has almost the same size. Why is this?**

**33b. How does the composition of Saturn's atmosphere compare to that of Jupiter, which is the same as that of the Sun?**

**34b. Which is the least dense planet in the solar system?**

C) Saturn

**55b. The source of excess heat emitted by Jupiter, above that which is absorbed as sunlight and reemitted, is thought to be**

C) gravitational potential energy released as heat during its formation stages, still being released.

**61b. Saturn's atmosphere does not show the same colorful contrast that we see in Jupiter's atmosphere. This is because**

C) Saturn has a similar circulation pattern to Jupiter, but it is obscured by a much deeper atmosphere.

**63b. One observational fact that is common to both Jupiter and Saturn is that**

D) both planets emit more energy (in the form of infrared radiation) than they receive from the Sun.

**64b. Saturn appears to emit heat as infrared radiation in excess of the energy absorbed from sunlight. The most likely major cause of this heating is**

A) condensation of helium into droplets that fall into the planet, releasing gravitational energy as heat.

**70b. Oblateness is a measure of the**

A) nonspherical shape of a planet, with the polar diameter being shorter than the equatorial diameter.

**71b. The reason for the slightly flattened or oblate shape of Jupiter is**

**75b. The deepest central cores of the interiors of Jupiter and Saturn are thought to be composed of**

D) rock.

**83b. The material in the interiors of Jupiter and Saturn thought to be responsible for their powerful magnetic fields is**

B) liquid metallic hydrogen.

**84b. The requirements for the generation of a powerful magnetic field in a Jovian planet (e.g., Jupiter, Saturn) appear to be**

A) liquid "metal" interior and relatively rapid rotation.

**103b. The shape and dimensions of the magnetosphere surrounding Jupiter are controlled by**

D) the pressure of the ionized gas of the solar wind against the planet's magnetic field.

**105b. On what planet would you not expect to find an aurora?**

A) Venus

**124b. The particles in Saturn's rings**

**126b. Which of the following describes the motions of the particles in the rings of Saturn?**

A) Each moves in almost circular Keplerian orbit around the planet.

**130b. The particles in Saturn's rings are composed of**

B) water ice or rock coated with water ice.

**132b. The Roche limit around a planet is defined as**

D) the distance inside which relative tidal forces will overcome the mutual gravitational forces of a group of particles.

**133b. The reason why the individual particles within Saturn's rings have not combined together by mutual gravitational attraction to form one or two moons is that**

**134b. The rings of Saturn are composed of very many small particles because**

B) they are inside the Roche limit of Saturn, where tidal forces are stronger than the mutual gravitational forces between particles.

**135b. The reason why boulder-sized moonlets are able to orbit within the Roche limit in Saturn's rings without being destroyed is that**

**150b. The gravitational effect that confines the particles of the F ring of Saturn to a narrow orbit is**

A) the gravitational influence of two small shepherding satellites in orbits adjacent to the ring.

## Chapter 15 (Lecture 23)

**1q. The Galilean satellites of Jupiter were not discovered until after the telescope was invented. What property of telescopes was required in order to make these satellites visible?**

(b) Telescopes increase the angular distance between objects. (The satellites are too close to Jupiter to be seen without a telescope.)

**3q. Which of the following parameters of the inner three Galilean satellites are linked by a simple mathematical relationship?**

(c) Orbital periods: Io orbits twice for each orbit of Europa while Europa orbits twice for each orbit of Ganymede.

**4q. On the basis of the relationship between the orbital periods of Io and Europa, how often would they come close together in their orbital paths?**

(b) Once every 2 Io orbits.

**7q. The fact that Jupiter's moons rotate on their axes in synchronism with their respective orbital motion, taking the same time to rotate as they do to revolve about the planet, was discovered long before detailed images of the moons were available from spacecraft. How was this first discovered?**

(a) Slight variations in moon brightness because of rotation were measured and seen to repeat every orbital period of the moon.

**9q. How big are the Galilean satellites of Jupiter, compared to other objects in the solar system?**

(c) About the size of our Moon, or a bit larger.

**13q. The source of heat that drives the volcanic eruptions of sulfur and sulfur compounds on Io, the giant moon of Jupiter, is**

(c) tidal distortion and flexing, caused by gravitational effects from Jupiter and other moons.

**16q. One very interesting fact about the lava that is seen to be flowing on Io is that**

(a) its temperature is significantly higher than that of lava upon the Earth, indicative of a different chemical composition.

**21q. What specific features led astronomers to conclude that Europa had undergone geological transformation in relatively recent times?**

(c) There are very few craters upon its surface.

**22q. If the surface of Europa, the Galilean moon of Jupiter, is considered to undergo a form of plate tectonics, what plays the role of the mantle upon which the plates slide around on the planet?**

(a) A layer of liquid water.

**25q. Titan, the largest satellite of Saturn, is the only planetary satellite to have a dense atmosphere. This atmosphere is thought to be composed mostly of**

(b) nitrogen, from the breakup of ammonia by solar UV light.

**26q. The source of the nitrogen atmosphere on Titan is probably**

(a) dissociation of ammonia by solar UV radiation, the nitrogen being left behind after the loss of the lighter hydrogen atoms.

**2b. The outer three Galilean moons of Jupiter differ from Io, the innermost such moon, by having surfaces of**

A) water ice.

**3b. The four giant moons of Jupiter were discovered by**

B) Galileo

**10b. Which of the following motions is seen to be characteristic of the four Galilean moons of Jupiter?**

D) They each keep the same face toward the planet at all times.

**13b. Brightness variations of Jupiter's moons as they orbit the planet indicate that the relation between the spin around their axes and their orbital motions is that the**

D) moons rotate exactly once per orbital period.

**14b. Because of mutual gravitational forces between the moons and the planet, the orbital periods of the three inner Galilean moons of Jupiter are in the ratio**

D) 1:2:4.

**15b. If the orbital period of Io, the innermost Galilean moon of Jupiter, is 1.77 days, what is the rotation period around its own axis?**

B) 1.77 days

**19b. In describing the observations of the movements of the moons of Jupiter, what is the difference between an occultation and an eclipse?**

**26b. The average densities of the Galilean moons of Jupiter follow which pattern with increasing distance from the planet?**

D) Average density decreases with distance from the planet.

**34b. Which satellite of Jupiter is volcanically active?**

D) Io

**35b. The most geologically active object in the planetary system at the present time is**

**39b. One of the most important sources of heat in the interiors of moons that orbit close to giant planets is**

B) continuous tidal distortion from other moons and the planet.

**40b. The heating of the interior of the large Galilean moon Io of Jupiter, in order to produce volcanic activity, is probably caused by**

D) tidal distortion by Jupiter and its other moons.

**54b. Which of the following are NOT seen on Jupiter's satellite Io?**

D) impact craters

**55b. Why does the innermost Galilean moon of Jupiter, Io, not show a cratered surface, as expected from the appearance of equivalent-sized objects like our Moon, Mercury, and Mars?**

C) Volcanic action recoats the surface regularly and continuously.

**58b. What peculiar feature accompanies Io in its orbit around Jupiter?**

A) a torus or ring of ionized sulfur, oxygen, atoms, and electrons

**59b. How is the Io plasma torus formed?**

C) Charged particles from Jupiter's magnetosphere ionize and eject atoms from Io's surface and from its volcanic plumes.

**66b. Which of the following objects in the solar system has the smoothest surface relative to its radius?**

D) Europa, a moon of Jupiter coated with water ice

**97b. Why do we suspect the existence of some liquid beneath the surface of Callisto?**

D) There is evidence of an induced magnetic field caused by Callisto's passage through Jupiter's magnetosphere.

**100b. Which of the following satellites of planets in our solar system has a significant, dense atmosphere?**

A) Titan, a moon of Saturn

**102b. Saturn's moon Titan is different from all other moons of planets because**

B) it possesses a thick atmosphere.

**107b. In what way was methane, CH<sub>4</sub>, first discovered on Titan, the giant moon of Saturn?**