

Date: Dec. 17, 2007

Instructor: Dr. Jie Zhang

Final Exam

I understand that this examination lasts from **7:30 PM to 10:15 PM**. I have not received, nor given any aid, nor assistance, nor answers, nor questions to anyone else during this examination period. I understand that any violation of the GMU honor code will result in my being reported directly to the honor committee, **without warning**. I understand that any honor code violation can cause me to fail the course, be suspended, and/or be expelled from the university; and, it will automatically be entered into my official records.

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Chap. 0: 1	1
Chap. 1: 3	4
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A: in order

B: (1-2) – (3,4), (5,6) – (7,8), (9,10) – (11,12), (13,14) – (15)

C: (1-2-3) – (4,5,6), (7,8,9) – (10,11,12), (13)–(14,15)

Note: Answer Keys --- asterisk symbol indicate the correct answer

(Chap. 0)

1. Your answer to question 1 must be "X"

(Chap. 1)

2. In applying the scientific method to the study of our natural surroundings, scientists are
 - A developing a theoretical view of the universe that incorporates all previous ideas and myths as part of an overall philosophy.
 - B *formulating hypotheses or models that describe the present observations of nature and that predict possible further tests for these models.
 - C discovering by observation the absolute truth about limited areas of science and are therefore slowly building up the correct view of the universe.
 - D slowly amassing a vast bank of observations of nature, which, at some time in the future, will be assembled into the correct description of the universe.

3. The average distance from Earth to the Sun, 149,600,000 km can be written in shorthand notation as
 - A 1.496×10^9 km.
 - B * 1.496×10^8 km.
 - C 1.496×10^7 km.
 - D 1.496×10^6 km.

4. One astronomical unit, or one AU is defined as the
 - A distance traveled by light in one year.
 - B *mean distance between the Sun and the Earth.
 - C distance from which Earth-Sun distance will subtend an angle of one arcsecond.
 - D distance traveled by light in one second.

(Chap. 2)

5. Constellations are generally made up of stars which are
 - A moving through space together.
 - B about the same age.
 - C actual groupings of stars physically bound together by gravity.
 - D *Merely located along more or less the same line of sight as viewed from Earth.

6. Over the course of one night, an observer at any given location on the Earth sees the constellations gradually move from east to west across the sky. This is caused primarily by the
 - A inherent rotation of the universe.
 - B wind.
 - C motion of the Earth around the Sun.
 - D *rotation of the Earth around its own axis.

7. If a star crossed the meridian at 1:00 am one night, then the next night it would cross at
 - A 1:04 am.
 - B 1:00 am.
 - C *12:56 am
 - D Stars don't cross the meridian. The meridian rotates with the sky.

8. The celestial equator is defined as the
 - A *line in the sky that is perpendicular to Earth's spin axis.
 - B line traced in our sky by the Moon each month against the background stars.
 - C line traced in our sky by the Sun over one year against the background stars.
 - D band of constellations through which the Sun and Moon move in our sky.

9. The ecliptic is defined as the
 - A line in the sky that is perpendicular to Earth's spin axis.
 - B line traced in our sky by the Moon each month against the background stars.
 - C *line traced in our sky by the Sun over one year against the background stars.
 - D band of constellations through which the Sun and Moon move in our sky.

10. When the Sun is at one of the equinoxes
 - A day and night are of equal length only for people on the equator.
 - B the day is longer than the night in one hemisphere of Earth and shorter in the other hemisphere.
 - C people on the equator have perpetual daylight.
 - D *day and night are of equal length everywhere on Earth.

11. What is the primary cause of Earth's seasons?
 - A The orbit of Earth is an ellipse, so Earth is not always the same distance from the Sun.
 - B *Earth's rotation axis tilts with respect to the plane of its orbit around the Sun.
 - C Earth's precession axis precesses (wobbles).
 - D In accord with Kepler's Second Law, Earth moves faster during parts of its orbit around the Sun and more slowly during other parts.

(Chap. 3)

12. Which of the following is the correct sequence of appearances of Moon phases in the sky?
- A new moon, full moon, waxing crescent, waning crescent
 - B *waxing crescent, first quarter, waxing gibbous, full moon
 - C full moon, waxing gibbous, third quarter, waning crescent
 - D new moon, waning crescent, first quarter, full moon
13. To observers on Earth, the Moon shows
- A its whole surface once per year as Earth moves around the Sun.
 - B its whole surface once per month as it rotates.
 - C *only one side to Earth at all times.
 - D only the sunlit side at all times.
14. The term "sidereal month" of the Moon refers to the
- A time from new moon to new moon.
 - B *time over which the Moon completes one orbit around Earth, relative to the stars.
 - C time from one lunar eclipse to the next.
 - D month containing Easter, as defined by the ecclesiastical calendar.
15. At the time of solar eclipse, the phase of the Moon is
- A full.
 - B first quarter.
 - C The Moon can be at any phase.
 - D *new.
16. lunar eclipse does not occur at every full moon because
- A a lunar eclipse cannot occur after sunset.
 - B the orbit of the Moon is not a perfect circle.
 - C *the plane of the Moon's orbit is at an angle to the plane of Earth's orbit.
 - D the path of the Sun is inclined at an angle of 5° to the ecliptic plane.
17. Assuming clear skies everywhere, a total solar eclipse is visible
- A to people anywhere in the sunlit hemisphere of Earth.
 - B to everyone on Earth.
 - C only over a region of Earth within 23.5° of Earth's equator, that is, in the tropics.
 - D *only to people in a long narrow path much smaller than a hemisphere.

(Chap. 4)

18. Retrograde motion of planets is explained in the Copernican heliocentric model of the solar system as
- A *a configuration that happens when the Earth overtakes a superior planet in its orbit.
 - B a configuration that takes place when a planet is at maximum elongation.
 - C a natural result of planets moving in ellipses around the Sun.
 - D when a planet slows down at aphelion.
19. When Mars is at opposition, it
- A rises at about midnight.
 - B is high in the sky at sunset.
 - C *is high in the sky at midnight.
 - D is high in the sky at noon.
20. Kepler's second law states that a line joining a planet to the Sun
- A sweeps through equal angles in equal times.
 - B points in the same direction at all times.
 - C *sweeps out equal areas in equal times.
 - D moves equal distances along the planet's orbit in equal times.
21. In the simplified version of Kepler's third law, $P^2 = a^3$, the units of the orbital period P and the semimajor axis a of the ellipses must be, respectively,
- A seconds and meters.
 - B years and meters.
 - C years and light years.
 - D *years and astronomical units.
22. If the mass of the Sun were doubled, the gravitational force on Earth due to the Sun would (Newton's law of gravitation: $F = GMm/R^2$)
- A stay the same.
 - B *be twice its present value.
 - C be four times its present value.
 - D be eight times its present value.
23. If Earth were to be moved to a distance of 2 AU from the Sun, how much stronger or weaker would be the Sun's gravitational force on Earth?
- A 2 times weaker
 - B *4 times weaker
 - C 2 times stronger
 - D 4 times stronger
24. How many "high tidal bulges" are there on the Earth, due to the Moon's gravitational pull?
- A one, on the side of the Earth facing away from the Moon
 - B four, one facing (almost) directly toward the Moon and the other three at 90 degree intervals from this one
 - C one, facing (almost) directly toward the Moon
 - D *two, one facing (almost) directly toward the Moon and one facing (almost) directly away from the Moon

(Chap. 5)

25. The speed of light in the vacuum is
- A 3.0×10^4 km/s
 - B 3.0×10^5 km/s
 - C 3.0×10^6 km/s
 - D 3.0×10^7 km/s
26. Visible light occupies which position in the whole electromagnetic spectrum?
- A between radio and infrared radiation
 - B *between infrared and ultraviolet
 - C between ultraviolet and X-rays
 - D between infrared and microwave
27. As a newly formed star continues to contract, its temperature increases. According to Wien's law, what happens to the peak wavelength of its emitted radiation?
- A *It moves toward shorter wavelengths (e.g., IR to visible).
 - B It moves toward longer wavelengths (e.g., visible to IR).
 - C It does not change, since it does not depend on temperature.
 - D It can not be predicted.
28. The spectrum of a pure blackbody is
- A *a continuous spectrum
 - B an absorption line spectrum
 - C an emission line spectrum
 - D any of the above
29. Atoms in a hot, low-density gas emit
- A a continuous spectrum
 - B an absorption line spectrum
 - C *an emission line spectrum
 - D any of the above
30. When astronomers look for evidence of hydrogen gas in the spectra of the Sun, the planets, and nearby stars, the positions of the spectral features or "lines" due to hydrogen
- A are in a very different pattern, depending on the location of the planet or star, and are reproduced only with difficulty in the laboratory.
 - B *are always in the same pattern, characteristic of hydrogen gas, as seen in the laboratory.
 - C change systematically, depending on the distance from the source, starting with a laboratory pattern.
 - D are in the same pattern for solar and planetary sources but are very different for stars.
31. An atom is now known to consist of a
- A crystalline structure of matter with electrons moving within it.
 - B *small, massive, electrically charged core with electrons surrounding it.
 - C small black hole with electrons held around it by intense gravitational forces.
 - D uniform distribution of matter with electrons embedded within it.

32. What happens when an electron in a hydrogen atom in the $n=2$ energy level jumps to the $n=3$ energy level
- A *It absorbs a photon
 - B It emits a photon
 - C It is ionized to become a free electron
 - D It collides with the proton.
33. The Doppler effect is the change in the wavelength of light caused by the source
- A being within a high gravitational field.
 - B being in an intense magnetic field.
 - C being embedded in a cloud of dust and gas.
 - D *moving with respect to the observer.

(Chap. 6)

(Chap. 7)

34. The correct sequence of planets in our solar system from the Sun outward is
- A Mercury, Venus, Earth, Mars, Saturn, Uranus, Jupiter, Neptune.
 - B Mercury, Earth, Venus, Mars, Jupiter, Saturn, Uranus, Neptune.
 - C Mercury, Venus, Mars, Earth, Jupiter, Saturn, Uranus, Neptune.
 - D *Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune.
35. The main characteristics of our solar system are
- A two large planets close to the Sun, two small planets next out, and four large planets farthest from the Sun.
 - B two small planets close to the Sun, five larger planets much farther from the Sun, and one small planet very far from the Sun.
 - C *four small planets close to the Sun and four large planets far from the Sun
 - D three small planets close to the Sun and five large planets far from the Sun.
36. In our solar system, which of the following planets is not a member of the Jovian group?
- A *Mars
 - B Saturn
 - C Neptune
 - D Jupiter
37. The Jovian planets have high masses and hence generate powerful gravitational fields, yet they have low average densities. What does this indicate about their interiors?
- A They are composed mainly of water.
 - B The interiors are hot and gaseous, like those of cool stars.
 - C They have not condensed to liquid or solid form.
 - D *They are composed mainly of light elements, such as H and He.
38. In general, large bodies in the solar system show less evidence of cratering than do small bodies. Why should we expect this correlation?
- A The gravity of large bodies deflects incoming projectiles and thus there are fewer collisions.
 - B *Large bodies cool more slowly and are more likely to retain internal heat and be geologically active, capable of resurfacing the planet and obliterating craters.
 - C Large bodies are more likely to retain an atmosphere, and thus most large projectiles burn up before striking the ground.
 - D Large bodies actually receive more hits because of their larger size, but later craters obliterate earlier ones, and we only see evidence of the most recent.
39. In order to produce a planet-wide magnetic field, a planet must have in its interior some material capable of carrying the electric current to produce a dynamo effect. All of the following substances appear to be able to fill this role, except one. Which is the exception?
- A molten iron
 - B *solid iron
 - C liquid metallic hydrogen
 - D a liquid water-ammonia mixture under high pressure

(Chap. 8)

40. The most common elements in the universe are
- A are quantities of heavy elements, with smaller quantities of hydrogen and helium.
 - B equal amounts of hydrogen and helium with small amounts of heavier elements.
 - C equal amounts of all elements up to iron but very little of any heavier elements.
 - D *hydrogen, smaller quantities of helium, and very small quantities of heavier elements.
41. The age of the solar system has been dated rather precisely to 4.56 billion years. What method was used to determine this number?
- A calculating the age of the Sun
 - B calculating the age of Earth by counting layers of geologic deposits
 - C determining the age of the Moon, which is older than Earth, by measuring the density of craters
 - D *determining the age of meteorites by radioactive dating
42. The origin of our solar system is believed to be
- A collision of two neutron stars
 - B a vast cloud of pure hydrogen.
 - C the convergence of the solar winds of several nearby stars.
 - D *a vast cloud of gas and dust.
43. Which of the following types of material has the highest condensation temperature in the planetary system?
- A hydrogen
 - B *rocks and dust grains
 - C nitrogen gas
 - D gases such as methane, ammonia, water vapor
44. Which substances form ice in the outer solar system?
- A carbon dioxide, iron oxides
 - B hydrogen and helium
 - C water, carbon dioxide, and minerals rich in iron, silicon, magnesium, and sulfur
 - D *water, methane, ammonia
45. The manner in which the terrestrial planets formed was
- A accretion of planetesimals to form a core, followed by gravitational capture of gas from the solar nebula.
 - B gravitational condensation of hydrogen, helium, and dust in eddies or vortices in the solar nebula.
 - C gravitational condensation of gas followed by capture of solid planetesimals.
 - D *accretion of solid planetesimals containing mostly rocky material.
46. The manner in which the Jovian planets formed was
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- C gravitational condensation of gas followed by capture of solid planetesimals.
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(Chap. 9)

47. The greenhouse effect heats a planet because
- A more sunlight gets in.
 - B the albedo is increased.
 - C *infrared radiation is trapped.
 - D the atmosphere becomes ionized.
48. To form the present structure of Earth, which of the following mechanisms is most likely to have taken place while Earth was molten?
- A *Heavy elements sank to the center under gravity, while lighter materials rose to the surface and solidified into rocks.
 - B Lighter elements sank to the center leaving the heavier material to form the rocky surface after cooling.
 - C Hydrogen and helium became highly compressed by gravity and sank to the core below a layer of heavier rocky material.
 - D All materials were thoroughly mixed by convection in the molten state, and Earth remained mixed as it cooled.
49. Which of the following techniques is used by geologists and geophysicists to probe the interior structure of Earth?
- A direct sampling of interior rock by deep drilling through the ocean floor
 - B extrapolation of surface features (e.g., mountain chains) into the deep interior
 - C *study the seismic waves produced by earthquakes
 - D X-ray analysis from satellites
50. The chemical makeup of the central core of Earth is considered to be
- A very close to that at the surface, silicon-rich rocks and minerals.
 - B iron-rich minerals.
 - C mainly solid hydrogen and helium similar to that of the giant planets.
 - D *almost pure iron.
51. The motions of large portions of Earth's surface, or "plates," are caused by
- A tidal forces from the Moon and the Sun, acting on continental landmasses.
 - B the varying pressure of Earth's atmosphere, both daily and seasonally.
 - C flexing of the surface due to solar heating and nighttime cooling.
 - D *convective flow of matter in Earth's interior.
52. The cratering which we see on the Moon is not found to the same extent on Earth at the present time because
- A the Moon protected Earth from impacts, and this resulted in the craters and maria on the Moon.
 - B interplanetary objects have avoided Earth during its history.
 - C *plate tectonics has returned cratered surface layers into Earth's interior, and weathering has obliterated the more recent craters.
 - D all the potentially damaging interplanetary bodies were stopped by Earth's atmosphere.
53. Earth's magnetosphere is
- A *a cavity in the solar wind carved out and controlled by Earth's magnetic field.

- B Earth's molten core where motion of electrically charged particles produces the magnetic field.
- C a layer in the atmosphere between stratosphere and thermosphere where motions are governed by magnetic effects.
- D a region of Earth's surface near the magnetic poles.

54. Billions of years ago, Earth's atmosphere was composed primarily of carbon dioxide. What happened to much of this carbon dioxide?

- A It is still in the atmosphere.
- B It was broken into carbon and oxygen by solar ultraviolet light.
- C *It dissolved into Earth's oceans.
- D It was lost to space.

(Chap. 10)

55. If viewed from a point directly above the plane of the planetary system, how would the Moon appear to rotate on its axis?
- A It would rotate once per year as Earth and Moon orbit the Sun together.
 - B It would not rotate at all, because we always see the same face on Earth.
 - C It would rotate once per day, to maintain its direction toward Earth.
 - D *It would rotate once per month, or once per revolution about Earth.
56. Most of the craters on the Moon were formed by
- A slumping of the surface following the outflow of lava from below the region.
 - B *bombardment by interplanetary meteoritic material.
 - C wind and water erosion of mountains and hills in the distant past.
 - D volcanic action; the craters are the old calderas of volcanoes.
57. What is the current state of plate tectonics on the Moon?
- A just in the process of beginning.
 - B very active, causing mountain uplift around the edges of several lunar maria
 - C dying out; only the lunar maria show signs of lava flow today.
 - D *absent; the Moon is a geologically dead world
58. The theory that seems to account most satisfactorily for the origin of the Moon at the present time is that
- A the Moon formed from material spun off from Earth when Earth was molten and spinning rapidly, early in its history.
 - B *a large object collided with Earth and ejected the material that formed the Moon.
 - C the Moon formed by accretion elsewhere in the solar system and was captured later by Earth.
 - D the Moon formed from material already in orbit around Earth.

(Chap. 11)-8

59. Where is Mercury when we have our best Earth-bound view of it?
- A *the greatest elongations
 - B inferior conjunction
 - C superior conjunction
 - D opposition
60. Venus has a higher surface temperature than Mercury. Which of the following is an explanation for this?
- A Venus is closer to the Sun than Mercury is.
 - B *Venus has a dense atmosphere of carbon dioxide, and thus a strong greenhouse effect.
 - C Venus is still contracting gravitationally and thus gives out more radiation than it receives.
 - D Venus has a higher albedo (reflectance) than Mercury.
61. Tectonic activity on Venus differs from that on Earth in that
- A active crustal deformation appears to be completely absent.
 - B *the lithosphere appears to be softer or more plastic and cannot support the creation and motion of solid plates (flake tectonics).
 - C the lithosphere appears to be cooler and thicker and is therefore too rigid to break up into moving plates.
 - D mantle convection appears to be more vigorous and has broken the lithosphere into a multitude of small plates instead of a few large ones.
62. How did the terrestrial planets, Venus, Earth and Mars, acquire their original atmospheres?
- A capture of solar wind gases from the Sun as they stream past the planets
 - B the impact and melting of icy comets from the planetary system and perhaps beyond
 - C gravitational capture of material from the original solar nebula by the planets
 - D *outgassing of the planets through volcanoes.
63. In which of the following ways are Venus and Mars alike, yet are both markedly different from Earth?
- A Their surface temperatures are both much higher than that of Earth.
 - B They are both perpetually shrouded in clouds.
 - C They both have either active or extinct volcanoes on their surfaces.
 - D *Their atmospheres are made up primarily of carbon dioxide.
64. What is the status of the greenhouse effect on Mars at the present time?
- A It no longer exists at all.
 - B *It is very weak and raises the planet's temperature only a few degrees above the temperature it would have with no atmosphere at all.
 - C It is weak but becoming stronger as Martian volcanoes continue to dump large amounts of CO₂ into the atmosphere.
 - D It is very strong and has caused the temperature to be at least 100 degrees above the temperature it would have been with no atmosphere at all.
65. Water on Mars today is principally found
- A in the atmosphere as vapor.

- B *in the polar ice caps and in permafrost in low latitudes.
- C in lakes and streams.
- D not in any place on Mars

66. The one terrestrial planet that rotates in the retrograde direction (opposite to the planet's direction of revolution around the Sun) is

- A Mars.
- B Earth.
- C *Venus.
- D Mercury.

(Chap. 12)-9

67. The zones and belts of Jupiter

- A *are cloud bands pulled into stripes by differential rotation.
- B are hurricanes created by a combination of heating and convection.
- C are rings of numerous small particles at different speed
- D are created by differential heating from metallic hydrogen.

68. What is the Great Red Spot on Jupiter?

- A *a large, long-lived, counterclockwise rotating storm maintained by high-speed wind and circulation in Jupiter's atmosphere
- B the point where charged particles from the satellite Io collide with Jupiter's cloud tops
- C a region over the south pole of Jupiter where ammonia compounds have condensed in the colder atmosphere
- D clouds above the summit of a large volcanic mountain

69. Detailed observations of Jupiter's rotation suggest that

- A *it is not a rigid object, because equatorial regions rotate faster than polar regions.
- B it rotates in two separate parts, equatorial regions rotating in a direction opposite to polar regions.
- C it is slowing down noticeably at the present time.
- D it rotates like a solid body, with equatorial and polar regions having the same rotational period.

70. Other than hydrogen and helium, the major components of the atmospheres of Jupiter and Saturn have been found to be

- A H₂O (water) and CO₂ (carbon dioxide).
- B N₂ (nitrogen), O₂ (oxygen), and CO₂ (carbon dioxide).
- C dust and iron oxides.
- D *CH₄ (methane), NH₃ (ammonia), and H₂O (water).

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

- A *its rapid rotation rate.
- B its cloud cover, more clouds forming over the equator on average.
- C that it was formed that way in the beginning and has maintained this shape.
- D the gravitational pull of the Sun and the other planets in the ecliptic.

72. The generation of a powerful magnetic field in Jupiter and Saturn appear to be

- A *liquid metallic hydrogen and relatively rapid rotation.
- B solid iron core forming a permanent magnet.
- C liquid "metal" core and interior and slow rotation.
- D solid interior throughout the planet and slow rotation.

73. Saturn's rings are

- A solid disk, much like a thin wheel.
- B *made of numerous small pieces of ice and rock
- C sparse collections of mountain-sized boulders.
- D several satellites which are moving so fast that they are flattened to have the ring shape

74. 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
- A the gravitational force from the Sun is sufficient to prevent coalescence.
 - B *tidal distortion forces from the planet are greater than the mutual gravity between the particles.
 - C the excess heating from Saturn has melted the ice on the rocks so that the rocks will no longer stick together.
 - D they are moving too fast to stick together even if they bump into one another.
75. The particles in Saturn's rings
- A move in circular orbits, with the outer particles moving fastest because they are farthest from the planet.
 - B all move as if they are one solid disk.
 - C revolve in different directions depending on the distance from the planet.
 - D *move in circular Keplerian orbits, the inner particles moving faster.

(Chap. 13)-7

76. What is significant about the rotational and revolutional motions of the four Galilean moons of Jupiter?
- A *synchronous rotation with one face always pointed toward the planet
 - B nonsynchronous rotation with independent periods of rotation and revolution, and spin axes perpendicular to their orbit
 - C nonsynchronous rotation with axes of rotation in any direction with respect to their orbital plane
 - D synchronous rotation with one face always pointed toward the Sun Saturn's moon
77. The most definitive evidence for water ice on Jupiter's satellites has come from
- A analysis of the albedos of these satellites.
 - B *spectroscopic observations.
 - C photographic images of the surfaces from the galileo flyby mission.
 - D temperature analysis of conditions on the surfaces.
78. In what important way does the Jupiter-moon system resemble a miniature Solar System, perhaps providing a hint to the initial formation of both systems?
- A The reflectivity of their surfaces decreases, the farther away they are from the central object, because the nearer objects have thicker clouds around them.
 - B *Average density of objects decreases as distance increases from the central object, because the heat from the central object would have melted and evaporated the volatile low-density ices from the closer objects.
 - C Average density of objects increases the farther away they are from the central object, because this central object can attract high-density material over a greater range of distances than for low-density material.
 - D There is no particular order of density of the objects with distance.
79. Io, one of the major Jupiter moons, is undergoing extensive volcanic activity associated with interior heating that is caused by
- A original heat, caused by gravitational condensation at the moon's formation.
 - B solar radiation and heat falling on the surface.
 - C the impact of Jupiter's Van Allen particles on Io's surface.
 - D *tidal distortion, and internal friction because of flexing.
80. What appears to have caused the extensive cracking and streaking of the surface of Europa?
- A *tidal flexing by Jupiter
 - B shrinking of the satellite as it cooled
 - C impacts by cometary debris
 - D expansion of the surface as the ice froze
81. Which of the moons of the giant planets is known to have a significant atmosphere?
- A *Titan, a moon of Saturn
 - B Triton, a moon of Neptune
 - C Callisto, a moon of Jupiter
 - D Europa, a moon of Jupiter

82. What observational facts lead to the conclusion that the small outer moons of Jupiter were captured by its gravitational field rather than being formed at the same time as the planet?

- A They move in circular orbits in the planet's equatorial plane in the same direction as Jupiter's rotation.
- B They move within the dust ring around Jupiter, above the planet's equator.
- C They move in circular orbits above the planet's equator in a retrograde direction, opposite to that of Jupiter's rotation.
- D *They move in orbits that are steeply inclined to Jupiter's equator, many of them in a retrograde direction, opposite to Jupiter's rotation.

(Chap. 14)-8

83. What are the most abundant gases in the atmosphere of Uranus?
- A *hydrogen and helium
 - B nitrogen and ammonia
 - C carbon dioxide and nitrogen
 - D methane and water
84. If Uranus has an orbital period of about 84 years, how far does it appear to move across the background sky in one year?
- A 0.23°
 - B 0.43°
 - C *4.3°
 - D 43°
85. How did the discovery of Neptune differ from the discovery of Uranus?
- A *Neptune's presence was first predicted using Newton's gravitational law to interpret deviations in the motion of another planet, whereas Uranus was discovered during sky searches.
 - B Neptune was discovered by accident by an amateur astronomer, whereas Uranus was found by professional astronomers doing specific searches for a new planet.
 - C Neptune was found during a survey of the sky, whereas Uranus was found after being predicted on the basis of their gravitational influence on the motions of neighboring planets.
 - D Neptune was discovered by photographic surveys of the sky, whereas Uranus was found by visual searches.
86. What is believed to be the basic structure of the interior of Uranus and Neptune?
- A *rocky core, liquid mantle, gaseous atmosphere
 - B iron core, liquid mantle, gaseous atmosphere
 - C rocky core, liquid mantle, icy crust
 - D iron core, rocky mantle, gaseous atmosphere
87. The most likely reason why Neptune shows significant cloud-forms and associated activity in its atmosphere, compared to the quiet atmosphere of Uranus, is that
- A Neptune does not have the deep, high-altitude layer of haze that blankets Uranus.
 - B Neptune is rotating much faster, thereby stirring the atmosphere into rotating storms like hurricanes on Earth.
 - C Neptune is closer to the Sun at the present time and receives more energy to cause more convection and turbulence.
 - D *Neptune has a significant source of internal heat that causes convection and turbulence.
88. How were the rings of Neptune first discovered?
- A direct photography from Earth
 - B direct photography by a flyby mission
 - C *occultation of a star as the rings moved in front of it
 - D ultraviolet emissions picked up by the Hubble Space Telescope

89. If you were standing on Pluto, how often would you see the satellite Charon rise above your horizon each day?
- A once every two days, because Charon orbits in the same direction as Pluto's rotation but more slowly
 - B twice in each 6-hour day, because Charon is in a retrograde orbit
 - C once in each 6-hour day as Pluto rotates on its axis
 - D *Never—Charon is a synchronous satellite like the communications satellites that are in orbit around Earth.
90. Pluto was disqualified as a normal planet in 2006 because of the following arguments except
- A Pluto's orbit is steeply inclined to the plane of the ecliptic.
 - B *Pluto has only one satellite.
 - C Pluto's orbit is highly eccentric.
 - D Pluto is too small in size, compared with those giant planets in the outer solar system.

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91. Most of the asteroids of our Solar System move around the Sun between the orbits of the planets
- A Earth and Mars.
 - B Jupiter and Saturn.
 - C *Mars and Jupiter.
 - D Venus and Earth.
92. The asteroid belt formed in part because
- A the proto-planet that was there broke up into fragments.
 - B *Jupiter's gravity prevented the asteroids there from coalescing into a planet
 - C Mars once orbited at that distance and stirred or churned it up preventing accretion into a planet.
 - D The temperature at that distance was too cold for asteroids to stick when they hit.
93. Most asteroids
- A are spherical in shape, with many craters on their surfaces.
 - B are spherical and ice-coated
 - C are irregularly shaped and ice-coated
 - D *irregular in shape with many craters on their surfaces
94. The major difference between the orbital paths of most asteroids and those of comets is that
- A comet orbits are mostly circular and in the ecliptic plane, whereas asteroids have elliptical orbits inclined at random to the ecliptic plane.
 - B comets never approach closer to the Sun than approximately Jupiter's orbit, whereas some asteroids approach very close to the Sun.
 - C asteroids orbit the Sun continuously, whereas all comets approach the Sun's vicinity only once before leaving the solar system.
 - D *comet orbits are highly elliptical and at random inclinations to the ecliptic plane, whereas asteroids have circular orbits in the ecliptic plane.
95. A small piece of rock orbiting the Sun would be called
- A a meteor.
 - B a meteorite.
 - C a micrometer.
 - D *a meteoroid.
96. Most comet nuclei are believed to be
- A chunks of rock or iron chipped from asteroids by impacts.
 - B large carbon chondrite meteoroids that have been set on fire by the Sun and are trailing long smoke trails.
 - C chunks of water and methane ice ejected from the surface of the icy satellites of the outer planets by asteroid impacts.
 - D *chunks of dirty ice left over from the formation of the solar system.
97. Which of the following governs the direction in which a comet's ion tail is aligned in space?
- A its direction of motion, because the tail simply trails behind it in its orbit
 - B the gravitational attraction of the Sun for the tail material

- C the gravitational attraction of Earth for the tail material
 - D *the flow of solar wind past the comet's nucleus
98. The orbits of comets are
- A *randomly oriented in the Solar System and can extend far beyond the orbit of Pluto.
 - B randomly oriented in the Solar System and confined to distances closer to the Sun than approximately the orbit of Pluto.
 - C primarily in the plane of the ecliptic and confined to distances closer to the Sun than approximately the orbit of Pluto.
 - D primarily in the plane of the ecliptic and can extend far out beyond the orbit of Pluto.
99. What is the Kuiper belt?
- A a band of dust in the plane of the ecliptic, extending from near the orbit of Mars to beyond the orbit of Pluto
 - B the broadest band of asteroids in the asteroid belt, separated from other bands by Kirkwood Gaps
 - C *a relatively flat distribution of objects in the plane of the ecliptic, extending from around the orbit of Pluto out to about 50 AU from the Sun
 - D an approximate spherical distribution of comets centered on the Sun, and extending out to about 50,000 AU
100. The Oort cloud is
- A a band of dust in the plane of the ecliptic, extending from near the orbit of Mars to beyond the orbit of Pluto
 - B the broadest band of asteroids in the asteroid belt, separated from other bands by Kirkwood Gaps
 - C a relatively flat distribution of objects in the plane of the ecliptic, extending from around the orbit of Pluto out to about 50 AU from the Sun
 - D *an approximate spherical distribution of comets centered on the Sun, and extending out to about 50,000 AU