BROCK UNIVERSITY

Final Examination: April 2008
Course: ASTR 1F00
Date of Examination: Monday, April 21, 2008
Time of Examination: 09:00 – 11:00

Number of Pages: 17
Number of Students: 472
Number of Hours: 2
Instructors: S. Bose and F. Fueten

Instructions: No examination aids other than a pocket calculator are permitted with this examination. Use or possession of unauthorized materials will automatically result in a grade of zero. Translation dictionaries (e.g., English-French) or other dictionaries (thesaurus, definitions, technical) are not allowed with this examination. Mark all answers on the **Scantron** sheet. Do not fold, staple or otherwise mutilate the Scantron sheet. **Use an HB or 2B pencil**. Be sure to **enter student number** in the box at the top of the **Scantron sheet**.

1. What is the Chandrasekhar limit?

   (a) The smallest mass a star can have and still burn hydrogen.
   (b) The maximum possible radius of a white dwarf.
   (c) The maximum possible mass of a white dwarf.
   (d) [None of the above.]

2. Disk stars are mostly Population I stars.

   (a) True.
   (b) False.

3. An emission nebula is bluish in colour.

   (a) True.
   (b) False.

4. The measured masses of galaxies are much larger than the mass in them that we can see (so-called luminous mass).

   (a) True.
   (b) False.

5. Population I stars are

   (a) dim and cool.
   (b) more than 10 billion years old.
   (c) metal rich.
   (d) metal poor.

6. The pulses seen from a pulsar are caused by

   (a) beams of radiation from a rapidly spinning neutron star sweeping across the viewer's line of sight.
   (b) the star's radius expanding and contracting as it burns iron in its core.

7. Distances to nearby galaxies are obtained using parallax.

   (a) True.
   (b) False

8. If the recession speed of galaxy A is five times that of galaxy B, the distance of A is

   (a) one fifth that of B.
   (b) five times that of B.

9. Globular clusters in the Milky way are found primarily

   (a) within the galactic disk.
   (b) in the galactic halo.

10. Stars in the halo of the Milky way move

    (a) in nearly circular orbits parallel to the galactic plane.
    (b) along elliptical orbits in random directions relative to the galactic plane.

11. To determine the mass of a galaxy, astronomers rely on

    (a) Hubble's law.
    (b) Wien's law.
    (c) Stefan-Boltzmann law.
    (d) Third Kepler's law as formulated by Newton.

12. Which of the following statements is NOT true about the nucleus of the Milky Way?

    (a) It is a source of infrared radiation, X-rays and gamma rays.
    (b) It is a source of radio waves.
    (c) It is visible by naked eye on a clear night.
    (d) It is less than 4 astronomical units in diameter and contains about 3 million solar masses.

13. The age of the Universe can be estimated from

    (a) the number of main sequence stars.
    (b) gravitational constant G.
    (c) Hubble constant H.
    (d) Planck constant h.

14. Prominent hydrogen spectral lines are observed in

(a) Type I supernova.
(b) Type II supernova.

15. The prediction of general relativity that a massive object bends spacetime was confirmed by observing

(a) the gravitational waves.
(b) the motion of Pluto.
(c) the bending of starlight during a solar eclipse.
(d) [None of the above.]

16. The star-star collision is less likely than galaxy-galaxy collision because

(a) the average distance between the stars is much larger than diameter of a star, while the distances between galaxies are comparable to their sizes.
(b) the stars within a galaxy stay in their orbits while the galaxy as a whole is moving relative to other galaxies.
(c) [The statement is wrong. The stars collide more frequently than the galaxies.]

17. If the luminosity of a quasar changes on a daily basis the size of the radiation source is about

(a) one light-year.
(b) one light-day.
(c) [No statement can be made.]

18. The beginning of helium fusion into carbon in the core of a low mass star is called

(a) helium era.
(b) helium phase.
(c) helium pump.
(d) helium flash.

19. Elliptical galaxies contain very little gas and dust.

(a) True.
(b) False.

20. During protostar stage a star derives its energy from

(a) fast spin.
(b) gravitational contraction.
(c) fusion of hydrogen into helium.
(d) magnetic field.

21. Type I supernova occurs when

(a) a large mass star explodes.
(b) a star comes too close to a black hole.
(c) a radiation beam from a pulsar strikes a main sequence star.
(d) [None of the above.]

22. Which of the following describes the evolution of the Sun?

(a) Protostar, main-sequence, red giant, neutron star.
(b) Protostar, main-sequence, red giant, white dwarf.
(c) Main-sequence, red giant, protostar

23. Gold is formed through nuclear fusion of lighter nuclei with a release of energy.

(a) True.
(b) False.

24. Astronomers believe that dark matter exists because

(a) they can detect it with radio telescopes.
(b) the outer parts of galaxies rotate faster than expected on the basis of visible matter in them.
(c) it is the only way to explain the black holes in active galaxies.
(d) the expansion of the Universe is accelerating.

25. What is meant by the cosmic background radiation?

(a) It is a radiation from distant quasars.
(b) It is radiation from hot gas in intergalactic space.
(c) It is radiation from the first stars formed when the Universe was young.
(d) It is radiation created in early stages of the Universe when it became transparent.

26. The more massive the star, the more time it spends in protostar stage.

(a) True.
(b) False.

27. What is meant by inflation in the early Universe?

(a) The force of gravity suddenly grew stronger in the distant past.
(b) The Universe increased dramatically in size in an extremely brief period of time when the strong nuclear force separated from the electroweak force.
(c) The number of protons increased dramatically in an extremely brief period of time.
(d) The number of photons increased dramatically in an extremely brief period of time.

28. Planetary nebula is another name for supernova remnant.

(a) True.
(b) False.

29. Most of supernova 1987A energy output (luminosity) was in the form of

(a) infrared radiation.
(b) visible light.
(c) neutrinos.
(d) gamma rays.

30. How are Type II supernova neutrinos produced?

(a) Two protons combine to form deuteron, positron and neutrino.
(b) Electrons in the iron core combine with protons to form neutrons and neutrinos.
(c) Iron nuclei in the core transform entirely into neutrinos.
(d) [None of the above.]

31. The density of a typical white dwarf is about 1000 kg per centimeter cubed. What prevents it from collapsing under its own gravity?

(a) Carbon atoms form a diamond structure which gives white dwarf mechanical strength.
(b) Pressure created by degenerate electrons.
(c) Pressure created by hot carbon atoms.
(d) [None of the above].

32. Which of the following has a radius (linear size) closest to that of a neutron star?

(a) The Sun.
(b) The Earth.
(c) A small city.
(d) A gymnasium.

33. The Schwarzschild radius of a body is a distance from its centre at which

(a) an orbiting companion will be broken apart by tidal forces.
(b) the escape velocity from it equals the speed of light.
(c) nuclear fusion ceases.
(d) convection becomes the dominant mechanism of energy transport.

34. If mass is added to a white dwarf,

(a) its radius increases.
(b) its radius decreases.
(c) its radius does not change.

35. Astronomers think that the Milky Way has spiral arms because

(a) globular clusters outline the spiral arms.
(b) young star clusters and associations outline the spiral arms.
(c) they are clearly visible in Sagittarius.
(d)[At present there is no evidence that the Milky Way has spiral arms.]

36. Harlow Shapley deduced that the Sun was not in the centre of the Milky Way by

(a) mapping the distribution of stars in the galaxy.
(b) mapping the distribution of globular clusters in the galaxy.
(c) mapping the distribution of gas and dust in the galaxy.
(d) [None of the above.]

37. In order to detect a black hole one looks for

(a) a star with an invisible companion.
(b) a star with a very massive invisible companion which is also an intense source of X-rays.
(c) a spot in the sky into which stars fall.
(d) [Black holes can never be detected as no light can escape from their gravity.]

38. A young blue star moving along a circular orbit of the Milky Way is

(a) Population I star.
(b) Population II star.

39. Type II supernovae are important because

(a) the elements heavier than iron are synthesized.
(b) neutrinos which they produce prevent galaxy from collapsing.
(c) all of star's hydrogen is returned to interstellar medium.
(d) they are used to detect the most distant galaxies.

40. If a probe was approaching the event horizon of a black hole the wavelength of the signals emitted by the probe would appear to us to be

(a) longer.
(b) shorter.
(c) unchanged.
(d) [No signals from the probe could be detected.]

41. Olbers' paradox is resolved if the Universe

(a) is not infinitely old.
(b) is infinitely old.
(c) is infinite in size.
(d) [The Olbers' paradox cannot be resolved.]

42. Observation of elliptical galaxies with multiple nuclei is taken as the evidence for

(a) the density wave theory.
(b) the Big Bang theory.
(c) galaxy mergers.
(d) [There are no elliptical galaxies with multiple nuclei.]

43. During the yellow giant stage of a low mass star energy is produced in the star's core via

(a) fusion of hydrogen into helium.
(b) fusion of helium into carbon.
(c) fusion of silicon into iron.
(d) gravitational contraction of the core.

44. Computer simulations suggest that the shape of the Whirlpool Galaxy resulted from gravitational distortion of two galaxies that passed near each other.

(a) True.
(b) False.

45. The microwave background radiation is well described by the

(a) Stefan-Boltzmann law.
(b) Wien's law.
(c) Hubble's law.
(d) Kepler's laws.

46. If the Sun could magically and suddenly become a black hole of the same mass the Earth would

(a) be pulled into the black hole.
(b) start moving tangentially to its previous orbit.
(c) stop moving altogether.
(d) continue moving in the same orbit.

47. When more material falls into a black hole, the radius of its event horizon

(a) increases.
(b) remains the same.
(c) decreases.
(d) [No prediction can be made.]

48. Why does a star expand into a red giant once its core stops producing energy?

(a) The energy transport within the star cannot catch up with a high rate of energy production in the hydrogen burning shell and the thermal pressure that builds up pushes out the top layers of the star.
(b) The shrinking dead core heats up and the resulting heat makes the entire star expand.
(c) Once the core stops producing energy its gravity is reduced and it cannot prevent the top layers from moving away.
(d) Radiation replaces convection as the energy transport mechanism and the radiation pressure lifts the top layers of the star.

49. A white dwarf of mass equal to two solar masses has been observed.

(a) True.
(b) False.

50. Astronomers use Cepheid variables to measure

(a) masses of galaxies.
(b) distances to nearby galaxies.
(c) velocities of galaxies.
(d) rotation curves of galaxies.

51. Both Jupiter and Saturn

(a) have liquid metallic hydrogen in their interiors.
(b) have rings.
(c) emit more energy than they absorb from the sun.
(d) have belt and zone circulation.
(e) all of the above

52. Jupiter's interior is mostly

(a) rock.
(b) molten iron.
(c) water.
(d) hydrogen and helium.
(e) carbon dioxide.

53. _____ are round bits of glass found in some stony meteorites.

(a) Chondrites
(b) Anthrosites
(c) Achondrites
(d) Widmanstätten patterns
(e) Chondrules

54. The Roche limit is

(a) the distance from the sun within which a planet can not retain an atmosphere.
(b) the minimum mass of an object in the solar system that would be classified as a planet.
(c) the maximum separation distance between the sun and a given planet.
(d) the distance from Earth at which we loose radio communication with a satellite.
(e) the distance from a planet within which a planet cannot hold itself together.

55. As a moon in a very elliptical orbit moves closer to and then farther from a planet, gravity flexes the moon with tides, and friction heats the interior. This process is referred to as

(a) tidal heating.
(b) occultation.
(c) vaporization.
(d) differentiation.
(e) sublimation.

56 Belt and zone circulation

(a) has been observed only on Jupiter.
(b) is caused by the planet's magnetic field.
(c) is caused by rising and sinking gases.
(d) is more obvious on Saturn than Jupiter.
(e) explains the formation of Cassini's division.

57. The oldest rocks found on Earth are about _____ years old.

(a) 10 billion
(b) 5.3 billion
(c) 4.6 billion
(d) 4.0 billion
(e) 6.2 million

58. The central regions of Earth's core are a solid because

(a) the composition at the center of the core is lower in iron.
(b) the pressure at the center raises the melting point.
(c) the magnetic field cannot penetrate into the center of the core.
(d) convection does not extend all the way to the center of the core.
(e) Earth initially formed from solid particles in the solar nebula.

59. Earth's magnetic field is generated by the dynamo effect in the

(a) molten metallic core.
(b) solid central core.
(c) plastic mantle.
(d) the crust.
(e) aurora.

60. The youngest parts of Earth's crust are

(a) the bottom layer found in the walls of the Grand Canyon.
(b) the continents.
(c) the continental margins.
(d) the Appalachian Mountains.
(e) the midocean rifts.

61. The oxygen in Earth's atmosphere

(a) was manufactured inside stars.
(b) was added to the atmosphere by plant life.
(c) has grown more abundant since the origin of Earth.
(d) all of these
(e) none of these

62. The _____ is a disk-shaped cloud of icy bodies believed to extend from about 40 AU out to 100 AU. It is believed that short period comets originate from this region.

(a) Oort cloud
(b) Widmanstätten cloud
(c) Apollo-Amor
(d) Kirkwood region
(e) Kuiper belt

63. The energy that moves the plates of Earth's crust comes from

(a) the solar wind.
(b) convection from the hot interior.
(c) tides in the oceans.
(d) friction between wind and the land surface.
(e) Earth's magnetic field.

64. The lunar maria are

(a) the lava plains of the lunar lowlands.
(b) the smooth plateaus of the lunar highlands.
(c) less than one billion years old.
(d) moving plates of lunar crust.
(e) older than the lunar highlands.

65. The density of Comet Halley was found to be about 0.2 g/cm^3. This implies that Comet Halley

(a) is composed of about 50% rock and 50% frozen water and methane.
(b) is loosely packed ices with a small amount of rocky material.
(c) formed in the inner solar system and was ejected by Jupiter to the Kuiper belt.
(d) is really an S-type asteroid.
(e) was once a moon of Neptune and was ripped away by a large impact.

66. The presence of breccias among the lunar rock samples shows that

(a) volcanism did not occur on the moon.
(b) molten lava once flowed over the lunar surface.
(c) the crust must have been made of anorthosite.
(d) water once existed on the moon in the form of small lakes and streams.
(e) the lunar surface was fragmented by meteorite impacts.

67. The geology of Venus appears to be dominated by

(a) volcanism.
(b) plate tectonics.
(c) erosion by flowing water.
(d) impact cratering.
(e) strip mining.

68. An asteroid could produce an iron core and a silicate mantle if it

(a) differentiated.
(b) outgassed.
(c) condensed.
(d) accreted.
(e) sublimed.

69. The greenhouse effect keeps Venus hot because

(a) the atmosphere contains free oxygen.
(b) the atmosphere is rich in carbon dioxide.
(c) the surface converts infrared into visible radiation.
(d) the surface is free of sulfur compounds.
(e) the magnetic field traps a large number of particles from the solar wind.

70. The condensation sequence suggests that _____ should condense closest to the sun.

(a) Jovian planets
(b) metals and metal oxides
(c) silicates
(d) ices of water, methane, and ammonia
(e) low density materials

71. Which of the solar system objects listed below is most similar to Earth in terms of mass and density?

(a) Mercury
(b) Moon
(c) Venus
(d) Mars
(e) Deimos

72. The crust of Mars is believed to _____ than Earth's.

(a) be much thinner
(b) be younger
(c) contain more water
(d) be more geologically active
(e) be much stronger

73. The moons of Mars are believed to be

(a) composed primarily of iron and nickel.
(b) composed primarily of frozen gases of water and carbon dioxide.
(c) orbiting Mars in a direction opposite to the direction that Mars rotates.
(d) formed from material ejected from Olympus Mons and other large volcanoes on Mars.
(e) captured asteroids.

74. Besides Earth, which of the terrestrial planets and/or satellites of terrestrial planets show(s) evidence for the possible existence of liquid water flowing on its surface in the past?

(a) Venus
(b) The Moon
(c) Phobos
(d) Mars
(e) None of the terrestrial planets or satellites show such evidence.

75. Most terrestrial planets have portions of their surface that appear to be significantly older than other portions of their surface. What evidence suggests that the surface of Venus is all of the same age?

(a) Photos taken by probes that landed on Venus showed that all of the rocks were of the same age.
(b) The craters on Venus are randomly distributed in size and number across the surface.
(c) The volcanoes on Venus are not found in isolated groups, but are scattered around the planet.
(d) a) and b)
(e) all of the above

76. One hypothesis suggested to explain the uniform age of the surface of Venus is that

(a) Venus' surface is 4 billion years old and has not been affected by flooding or slow evolution.
(b) Venus' surface is made of rocks that are much harder than Earth's and thus last longer.
(c) Venus periodically goes through a catastrophic melting of the entire surface.
(d) Venus' clouds protect it from meteorites so that very few impacts occur to change its surface.
(e) dust storms deposit large amount of dust on the surface making it appear of uniform age.

77. Mercury's major atmospheric gas is

(a) oxygen.
(b) hydrogen.
(c) carbon dioxide.
(d) Misleading; the atmosphere is virtually nonexistence.

78. Which of the terrestrial planets has the most difficult time retaining an atmosphere?

(a) Mercury
(b) Venus
(c) Earth
(d) Mars

79. What physical property of Venus is vastly dissimilar compared to Earth?

(a) Radius
(b) Mass
(c) Density
(d) Surface temperature

80. In what way is the rocky material of Jupiter's core different from the rocks found on Earth?

(a) It is much cooler because Jupiter is further from the sun.
(b) It contains more liquid water.
(c) It is much hotter and denser because of the extreme pressure at the core of Jupiter.
(d) It is composed of iron and nickel because this material will settle to the core.
(e) It is composed entirely of ices that have frozen into a large rock-like structure.

81. Which planet has the highest *average* surface temperature, and why?

(a) Mercury, because it is closest to the Sun.
(b) Mars, because of its red colour.
(c) Venus, because of its dense carbon dioxide atmosphere.
(d) Mercury, because of its dense carbon dioxide atmosphere.
(e) Jupiter, because it is so big.

82. The most metal rich terrestrial planet is:

(a) Venus.
(b) Mars.
(c) The Moon.
(d) Earth.
(e) Mercury.

83. The terrestrial planet cores contain mostly metal because

(a) convection carried the metals to the core.
(b) metals condensed first in the solar nebula and the rocks then accreted around them.
(c) radioactivity created metals in the core from the decay of uranium.
(d) the entire planets are made mostly of metal.
(e) metals sank to the center during a time when the interiors were molten throughout.

84. Other than at Hydrogen and Helium the cosmic abundance curve has a significant peak at:

(a) Lithium
(b) Potassium
(c) Iron
(d) Lead
(e) Uranium

85. Most asteroids orbit the Sun:

(a) between Earth and Mars
(b) between Mars and Jupiter
(c) between Jupiter and Saturn
(d) beyond the orbit of Saturn
(e) [None of the above. No general statement can be made.]

86. The formation of the planets took approximately:

(a) 2 million years
(b) 20 million years
(c) 200 million years
(d) 2000 million years
(e) 2000 million gazillion years

87. Which of the following does *not* have a major effect in shaping planetary surfaces?

(a) magnetism
(b) volcanism
(c) impact cratering
(d) tectonics
(e) erosion

88. On the surface of Mars we observe:

(a) giant volcanoes
(b) polar caps
(c) vast canyons
(d) dry riverbeds
(e) all of the above

89. If we list the terrestrial planets in the order of increasing amount of atmosphere, the list should read:

(a) Mercury, Venus, Earth, Mars
(b) Mercury, Mars, Earth, Venus
(c) Mercury, Earth, Mars, Venus
(d) Mars, Mercury, Earth, Venus
(e) Mercury, Mars, Venus, Earth

90. The relatively few craters that we see within the lunar *maria*

(a) are volcanic in origin, rather than from impacts.
(b) were formed by impacts that occurred after those that formed most of the craters in the lunar highlands.
(c) were formed by impacts that occurred before those that formed most of the craters in the lunar highlands.
(d) are sinkholes that formed when sections of the *maria* collapsed.
(e) were created by the same large impactor that led to the formation of the *maria*.

91. Comets falling into the inner solar system from the _____ become long-period comets.

(a) Oort cloud
(b) asteroid belt
(c) Roche limit
(d) Kuiper belt
(e) Widmanstätten region

92. Why do we think Mercury has so many tremendous cliffs?

(a) They were probably carved in Mercury's early history by running water.
(b) They were probably formed by tectonic stresses when the entire planet shrank as its core cooled.
(c) They represent one of the greatest mysteries in the solar system, as no one has suggested a reasonable hypothesis for their formation.
(d) They probably formed when a series of large impacts hit Mercury one after the other.
(e) They are almost certainly volcanic in origin, carved by flowing lava.

93. *Olympus Mons* is a

(a) shield volcano on Mars.
(b) large lava plain on the Moon.
(c)) shield volcano on Venus.
(d) stratovolcano on Mercury.
(e) stratovolcano on the Moon.

94. The present widening of the Atlantic Ocean is caused by

(a) gravitational forces exerted on the Earth by the Moon.
(b) the Earth expanding as its core material expands as a result of it gradually losing heat.
(c) the tidal force on the Earth exerted by the Sun.
(d) plate tectonic motions associated with convection in the Earth's interior.
(e) magnetic pressure that builds up in the Earth as it spins.

95. What was the *frost line* of the solar system?

(a) The distance from the Sun where temperatures were low enough for metals to condense, between the Sun and the present-day orbit of Mercury.
(b) The distance from the Sun where temperatures were low enough for hydrogen and helium to condense, between the present-day orbits of Jupiter and Saturn.
(c) The distance from the Sun where temperatures were low enough for rocks to condense, between the present-day orbits of Mercury and Venus.
(d) The distance from the Sun where temperatures were low enough for hydrogen compounds to condense into ices, between the present-day orbits of Mars and Jupiter.
(e) The distance from the Sun where temperatures were low enough for asteroids to form, between the present-day orbits of Venus and Earth.

96 The age of the solar system can be established by radioactive dating of

(a) the oldest rocks on the earth.
(b) the atmosphere of Mars.
(c) the oldest rocks on the Moon.
(d) the oldest meteorites.
(e) It hasn't been done yet, but the age of the solar system could be obtained from a sample of Io's surface.

97. Compared to the terrestrial planets, Jovian planets

(a) have a higher density.
(b) have a smaller number of moons.
(c) have a much larger diameter.
(d) are much hotter.

98. If the catastrophic theory of the formation of the solar system is correct then we should expect

(a) to find many planetary systems like our own.
(b) to find a very few number of planetary systems like our own.
(c) to find no other planetary system anywhere in the universe.
(d) Misleading; the catastrophic theory is not a theory of planetary format

99. The Widmanstätten patterns found in some meteorites show that the material

(a) cooled very slowly.
(b) cooled very rapidly.
(c) was never heated to the point of being molten.
(d) was molten just before it entered Earth's atmosphere.
(e) is composed primarily of organic compounds.

100. The energy that moves the plates of Earth's crust comes from

(a) the solar wind.
(b) convection from the hot interior.
(c) tides in the oceans.
(d) friction between wind and the land surface.
(e) Earth's magnetic field.