BROCK UNIVERSITY

Final Exam: July 2018
Course: ASTR 1P02
Examination date: 6 July 2018
Time of Examination: 16:00 – 18:00 pm

Number of pages: 18
Number of students: 315
Time limit: 2 hours
Instructor: S. D'Agostino

Answer all questions on the answer sheet provided. No aids permitted except for a non-programmable calculator (this regulation does not preclude special arrangements being made for students with disabilities). Translation dictionaries (e.g., English-French) or other dictionaries (thesaurus, definitions, technical) are not allowed. Use or possession of unauthorized materials or electronic devices will result in a charge of academic misconduct under the University's Academic Integrity Policy.

Each question is worth 1 mark. Total number of marks: 100.

Return both the exam script and your answer sheet when you leave the exam room.

1. Main sequence stars are in hydrostatic equilibrium, which means that
   (a) the outward gas pressure is balanced by the inward conduction force.
   (b) the outward gas pressure is balanced by the inward electromagnetic force.
   (c) the outward convection pressure is balanced by the inward conduction force.
   (d) the outward radiation pressure is balanced the the inward conduction force.
   (e) [None of the above.]
2. In the inner layers of the Sun, the primary way energy is transported outwards is
   (a) conduction.
   (b) convection.
   (c) nuclear fusion.
   (d) radiation.
3. In the outer layers of the Sun, the primary way energy is transported outwards is
   (a) conduction.
   (b) convection.
   (c) nuclear fusion.
   (d) radiation.
4. In an ordinary main-sequence star,
   (a) the star's core has higher temperature and higher pressure than its outer layers.
   (b) the star's core has higher temperature and lower pressure than its outer layers.
   (c) the star's core has lower temperature and higher pressure than its outer layers.
   (d) the star's core has lower temperature and lower pressure than its outer layers.

5. Astronomers often speak informally about hydrogen fuel "burning" in the core of a star, but what really happens to the hydrogen is that it undergoes

   (a) nuclear fission.
   (b) nuclear annihilation chain reactions.
   (c) a Type-I phase transition.
   (d) a Type-II phase transition.
   (e) [None of the others.]

6. The net result of a proton-proton chain reaction is that the total number of protons and neutrons in a star's core

   (a) decreases.
   (b) remains the same.
   (c) increases.

7. The temperature of the Sun's core is

   (a) about 58 K.
   (b) about 580 K.
   (c) about 5,800 K.
   (d) much greater than any of the numbers listed above.

8. The rate at which nuclear fusion reactions occur in a gas

   (a) increases if the temperature increases, and increases if the pressure increases.
   (b) increases if the temperature increases, and decreases if the pressure increases.
   (c) decreases if the temperature increases, and increases if the pressure increases.
   (d) decreases if the temperature increases, and decreases if the pressure increases.

9. The solar neutrino problem was solved with the aid of data collected over many years by the

   (a) ANO, near Lethbridge, Alberta.
   (b) CNO, near Comox, British Columbia.
   (c) QNO, near Ungava Bay, Québec.
   (d) SNO near Sudbury, Ontario.
   (e) TNO near Tuktuyaaqtuuq, Northwest Territories.

10. The main-sequence lifetime of a blue giant is _____ the main-sequence lifetime of a red dwarf.

    (a) greater than
    (b) less than
    (c) about the same as

11. Main-sequence stars with masses much greater than the Sun's mass primarily use _____ for their fusion reactions.

    (a) the CNO cycle
    (b) the Krebs cycle
    (c) the proton-proton chain
    (d) the recumbent cycle
    (e) the SNO chain

12. Main-sequence stars with masses of about the Sun's mass or less primarily use _____ for their fusion reactions.

    (a) the CNO cycle
    (b) the Krebs cycle
    (c) the proton-proton chain
    (d) the recumbent cycle
    (e) the SNO chain

13. Emission nebulae typically appear

    (a) blue.
    (b) green.
    (c) red.
    (d) yellow.
    (e) [None of the above.]

14. The formation of protostars can be triggered by

    (a) accumulations of dark matter in galactic haloes.
    (b) migrations of interstellar storks.
    (c) power outages in galactic energy grids.
    (d) shock waves passing through giant molecular clouds.

15. When a main-sequence star runs out of hydrogen fuel in its core,

    (a) it must refuel at a galactic gas station, or suffer hardship during the cold interstellar winter.
    (b) dramatic changes occur in the star's electric field.
    (c) dramatic changes occur in the star's axion output.
    (d) dramatic changes occur in the star's structure.

16. When a main-sequence star runs out of hydrogen fuel in its core, and the core becomes hot enough, the next element to begin fusing is

    (a) carbon.
    (b) helium.
    (c) iron.
    (d) oxygen.

17. A planetary nebula is produced by

    (a) the expanding atmosphere of a gas-giant planet.
    (b) the end-stage evolution of a medium-mass star.
    (c) convection in the outer layers of a main-sequence star.
    (d) convection in the inner layers of a main-sequence star.

18. When the sun is in its red-giant phase, its diameter will be about _____ larger than it is now.

    (a) 100 times
    (b) 10,000 times
    (c) 1,000,000 times
    (d) 100,000,000 times

19. A binary star system that include a white dwarf may produce

    (a) long-period comets.
    (b) short-period comets.
    (c) an increased gravitino flux.
    (d) a type Ia supernova.

20. Giant molecular clouds, from which stars will eventually form, are

    (a) very hot and dense.
    (b) very hot and not very dense.
    (c) cold and dense.
    (d) cold and not very dense.

21. As a contracting protostar heats up, if the core temperature reaches 10 million degrees K then

    (a) hydrogen fusion begins and the protostar becomes a main-sequence star.
    (b) the protostar is ready to start grilling hamburgers.
    (c) a temperature inversion occurs due to convection in the core.
    (d) core fluorescence commences.

22. "Stars" with masses of less than about 0.08 solar masses never get hot enough to fuse hydrogen into helium, and are called

    (a) white dwarfs.
    (b) red dwarfs.
    (c) brown dwarfs.
    (d) black dwarfs.

23. A typical main-sequence star is

    (a) much smaller than the Earth.
    (b) slightly smaller than the Earth.
    (c) about the same size as the Earth.
    (d) slightly larger than the Earth.
    (e) much larger than the Earth.

24. Stars with masses of about 0.4 solar masses or slightly less are called

    (a) white dwarfs.
    (b) red dwarfs.
    (c) brown dwarfs.
    (d) black dwarfs.

25. The most important factor influencing the main-sequence lifetime of a star is its

    (a) chemical composition.
    (b) colour.
    (c) mass.
    (d) shape.

26. If a collapsing star has a mass greater than the Chandrasekhar limit, then it

    (a) fails to leave the main sequence.
    (b) eventually becomes a neutron star or black hole.
    (c) eventually becomes a quasar.
    (d) eventually becomes a white dwarf.

27. Eventually, a white dwarf will stop emitting light, but this is expected to take

    (a) several years.
    (b) several thousand years.
    (c) several million years.
    (d) several billion years.
    (e) [None of the others.]

28. A teaspoonful of material from a white dwarf has a mass of about

    (a) the same amount of air.
    (b) the same amount of rock.
    (c) 10 tonnes.
    (d) 1,000,000 tonnes.

29. A neutron star is a remnant of a

    (a) type Ia supernova.
    (b) type II supernova.
    (c) planetary nebula.
    (d) giant molecular cloud.

30. A black hole is a remnant of a

    (a) type Ia supernova.
    (b) type II supernova.
    (c) planetary nebula.
    (d) giant molecular cloud.

31. As the fusion of progressively heavier nuclei takes place in the later stages in the lifetime of a very massive star, each stage of fusion takes

    (a) progressively less time.
    (b) about the same amount of time.
    (c) progressively more time.

32. In the evolution of a very massive star, energy production declines when the core contains primarily

    (a) carbon.
    (b) hydrogen.
    (c) lithium.
    (d) uranium.
    (e) [None of the above.]

33. The chemical element that has the greatest nuclear binding energy per nucleon is

    (a) carbon.
    (b) hydrogen.
    (c) iron.
    (d) uranium.
    (e) [None of the above.]

34. The most recent Type II supernova visible with the naked eye was the famous SN1987A, discovered by Canadian astronomer

    (a) Christine Elliott.
    (b) Andrea Horwath.
    (c) Caroline Mulroney.
    (d) Kathleen Wynne.
    (e) [None of the others.]

35. A pulsar is _____ that emits regular pulses of electromagnetic radiation.

    (a) an oscillating binary star system containing at least one main-sequence star
    (b) a pulsating black hole
    (c) a vibrating quasar
    (d) a rotating neutron star
    (e) [None of the above.]

36. Strong evidence for Einstein's theory of gravity has been provided by precision measurements on

    (a) binary pulsars.
    (b) twinned black holes.
    (c) Type II supernovae.
    (d) globular clusters.
    (e) Bragg scattering.

37. The escape velocity in the region inside a black hole's Schwarzschild radius is

    (a) greater than the speed of light.
    (b) equal to the speed of light.
    (c) less than the speed of light.

38. Experimental evidence for black holes includes the emission of X-rays by an object in a binary star system. The X-rays are produced by

    (a) fluorescence.
    (b) the piezoelectric effect.
    (c) the black hole's gyromagnetic circulation.
    (d) the acceleration of charged particles falling into the black hole.
    (e) [None of the others.]

39. To accurately describe the behaviour of light in the vicinity of massive astronomical objects such as white dwarfs, neutron stars, and black holes, one needs

    (a) Bode's law.
    (b) Einstein's theory of general relativity.
    (c) Kepler's laws.
    (d) Newton's laws.
    (e) [None of the above.]

40. Einstein's theories of special relativity and general relativity are both essential for

    (a) fabricating silicon wafers used in modern computers.
    (b) the proper functioning of the GPS.
    (c) the design and construction of ultra-thin smart-phone screens.
    (d) cross-country electric power transmission.
    (e) [None of the others.]

41. Elliptical galaxies typically contain

    (a) a lot of gas and dust.
    (b) a lot of dust, but very little gas.
    (c) an unusually large amount of gas, but very little dust.
    (d) very little gas and dust.

42. Elliptical galaxies contain mostly

    (a) Population I stars and tend to be red.
    (b) Population I stars and tend to be blue.
    (c) Population II stars and tend to be red.
    (d) Population II stars and tend to be blue.

43. In the 18th century it was proposed by Thomas Wright and Immanuel Kant that

    (a) the solar system is subject to the laws of Newtonian mechanics.
    (b) space between galaxies is expanding.
    (c) our galaxy's shape is roughly a disk.
    (d) the age of the universe is finite.

44. Our location in the Milky Way was established by

    (a) David Bohm.
    (b) Greta Garbo.
    (c) Mickey Rooney.
    (d) J. Robert Oppenheimer.
    (e) Harlow Shapley.

45. The method of Cepheid variables was pioneered by

    (a) Lajos Portisch.
    (b) Henrietta Swan Leavitt.
    (c) Fridrik Olafsson.
    (d) Gyula Sax.

46. According to the Big Bang theory, neutral hydrogen atoms formed about _____ after the Big Bang.

    (a) 380 years
    (b) 380 thousand years
    (c) 380 million years
    (d) 380 billion years

47. The Large Hadron Collider (LHC) first detected the Higgs boson in

    (a) 1712.
    (b) 1812.
    (c) 1912
    (d) 2012.

48. Light from distant stars has its path bent by the gravitational effect of matter between us and the source of the light. This is predicted by the theory of

    (a) Fermi-Dirac condensation.
    (b) Landau phase transitions.
    (c) quantum mechanics.
    (d) topological defects.
    (e) [None of the others.]

49. The diameter of the Milky Way's disk is approximately

    (a) 100 light years.
    (b) 100,000 light years.
    (c) 100,000,000 light years.
    (d) [None of the above.]

50. Gas and dust in the Milky Way is

    (a) distributed approximately uniformly.
    (b) concentrated in the bulge.
    (c) concentrated in the halo.
    (d) concentrated in the spiral arms.

51. The age of the universe is approximately the reciprocal of the

    (a) Bourbon constant.
    (b) Hapsburg constant.
    (c) Hubble constant.
    (d) Windsor constant.
    (e) [None of the above.]

52. Just after the Big Bang, the universe was in a _____ state.

    (a) cool and not very dense
    (b) cool and very dense
    (c) hot and not very dense
    (d) hot and very dense
    (e) [This is currently unknown.]

53. The universe has approximately the same properties in all directions, which means that it is

    (a) adiabatic.
    (b) homogeneous.
    (c) isothermal.
    (d) isotropic.
    (e) [None of the above.]

54. The universe has approximately the same properties in all its sufficiently large regions, which means that it is

    (a) adiabatic.
    (b) homogeneous.
    (c) isothermal.
    (d) isotropic.
    (e) [None of the above.]

55. Population I stars have a concentration of heavy elements of about

    (a) 2%–3%.
    (b) 20%–30%.
    (c) 80%–90%.
    (d) [None of the above.]

56. The solar nebula theory proposes that

    (a) planets form in rotating disks of gas and dust around young stars.
    (b) the Sun will become a nebula after its red giant stage.
    (c) sunspots occur because the Sun sweeps up magnetic material from a cloud of gas and dust.
    (d) the solar wind interacts with the Oort cloud to produce the Kuiper belt.

57. The average density of Jovian planets is _____ the average density of terrestrial planets.

    (a) less than
    (b) about equal to
    (c) greater than

58. The average diameter of Jovian planets is _____ than the average diameter of terrestrial planets.

    (a) less than
    (b) about equal to
    (c) greater than

59. The surfaces of Jovian planets are _____ the surfaces of terrestrial planets.

    (a) colder than
    (b) about the same temperature as
    (c) warmer than

60. The orbits of the planets around the Sun lie

    (a) approximately on the celestial sphere.
    (b) approximately in a spiral.
    (c) approximately in an egg-shaped surface.
    (d) in chaotic directions.
    (e) [None of the above.]

61. The total mass of the eight planets in our solar system is _____ the mass of our Sun.

    (a) much less than
    (b) slightly less than
    (c) about equal to
    (d) slightly greater than
    (e) much greater than

62. The interiors of the Jovian planets contain small cores of

    (a) caramel.
    (b) carbon.
    (c) lava.
    (d) ricotta.
    (e) [None of the above.]

63. The distance from Jupiter to the Sun is about

    (a) 5 AU.
    (b) 5 thousand AU.
    (c) 5 million AU.
    (d) 5 billion AU.

64. Radioactive dating is useful for determining the ages of

    (a) celestial bodies on the dating site *Plenty of Planets*.
    (b) stellar atmospheres.
    (c) planetary atmospheres.
    (d) rocks found in the solar system.
    (e) [None of the above.]

65. A planet with no known satellites (moons) is

    (a) Mercury.
    (b) Mars.
    (c) Uranus.
    (d) Neptune.

66. The largest satellite (moon) of a planet in our solar system has a diameter that is _____ times as large as Earth's Moon.

    (a) 10
    (b) 100
    (c) 1,000
    (d) [None of the others.]

67. Saturn is the only planet in our solar system with rings.

    (a) True
    (b) False

68. Chunks of frozen gases with solid particles mixed in are called

    (a) asteroids.
    (b) comets.
    (c) meteors.
    (d) ziggurats.
    (e) [None of the others.]

69. Most of the craters in the solar system appear to have been formed about

    (a) 4 million years ago
    (b) 4 billion years ago
    (c) 4 trillion years ago
    (d) [None of the above.]

70. Comets are typically

    (a) smaller than a house.
    (b) a few tens of kilometres in size.
    (c) typically larger than the Moon, but smaller than the Earth.
    (d) typically larger than the Earth.

71. Small chunks of rock that fly through the solar system are called

    (a) meteorinos.
    (b) meteorites.
    (c) meteoroids.
    (d) meteors.

72. Small chunks of rock that leave a streak of light as they fly through Earth's atmosphere are called

    (a) meteorinos.
    (b) meteorites.
    (c) meteoroids.
    (d) meteors.

73. Small chunks of rock that have landed on Earth after coming from outer space are called

    (a) meteorinos.
    (b) meteorites.
    (c) meteoroids.
    (d) meteors.

74. A large crater on Earth that is associated with the extinction of the dinosaurs is the

    (a) Areceibo crater in Puerto Rico.
    (b) Barringer crater in Arizona, U.S.
    (c) Ocampo crater in Argentina.
    (d) Tunguska crater in Russia.
    (e) [None of the above.]

75. The two moons of Mars, Phobos and Deimos, are most likely

    (a) to have been ejected from Mars.
    (b) to have formed along with Mars from the same clump of gas and dust.
    (c) to have been meteorites.
    (d) to have been meteors.
    (e) to be captured asteroids.

76. The largest mountain in the solar system is on the surface of

    (a) Earth.
    (b) Mars.
    (c) Jupiter.
    (d) Neptune.
    (e) [None of the above.]

77. The atmosphere of _____ is cool, about 1% as dense as Earth's atmosphere, and is about 95% carbon dioxide.

    (a) Mercury
    (b) Venus
    (c) Mars
    (d) the Moon
    (e) [None of the above.]

78. The atmosphere of _____ is extremely hot, about 90 times more dense than Earth's atmosphere, and is about 95% carbon dioxide.

    (a) Mercury
    (b) Venus
    (c) Mars
    (d) the Moon
    (e) [None of the above.]

79. In planet formation, the process of differentiation causes

    (a) denser substances to move towards the core of a planet and less dense substances to move towards the surface.
    (b) larger planets to move towards the outer region of the solar system and smaller planets to move towards the inner region of the solar system.
    (c) planetary orbits to nearly align along a plane.
    (d) the overall angular momentum of the solar system to move into the Oort cloud.
    (e) [None of the above.]

80. Among terrestrial planets, the largest is

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

81. Extrasolar planets, also called exoplanets, are found

    (a) in the Kuiper belt.
    (b) in the Oort cloud.
    (c) in the asteroid belt.
    (d) orbiting stars outside of our solar system.

82. In the Milky Way galaxy, star formation is most common

    (a) in the celestial sphere.
    (b) in the halo.
    (c) in the central bulge.
    (d) in the spaces between the spiral arms.
    (e) [None of the above.]

83. That galaxies are generally moving away from each other is described by

    (a) Einstein's law.
    (b) Hubble's law.
    (c) Kepler's laws.
    (d) Newton's laws.
    (e) Zeffirelli's principle.

84. Observed fluctuations in the cosmic microwave background are currently tiny, which implies that
    (a) the Big Bang was big and it banged.
    (b) the early universe was hot and dense.
    (c) matter was almost uniformly distributed in the early years after the Big Bang.
    (d) light and matter were in magnetic equilibrium in the recombination era.
    (e) [None of the others.]

85. The temperature of cosmic microwave background radiation and the fact that it is similar in all directions provides strong evidence for the
    (a) the Big Band era of jazz music.
    (b) the Big Bang theory of the formation of the universe.
    (c) Einstein's theory of gravitation.
    (d) Maxwell's theory of electromagnetic radiation.

86. The cosmic microwave background radiation was first observed
    (a) by ancient astronomers.
    (b) by Galileo Galilei.
    (c) by Johannes Kepler.
    (d) by Isaac Newton.
    (e) [None of the above.]

87. The temperature 3 K is the current temperature of the
    (a) atmosphere of Saturn.
    (b) cosmic microwave background radiation.
    (c) Milky Way's nucleus.
    (d) Sun's corona.
    (e) [None of the others.]

88. If the average density of the universe is large enough, then the universe
    (a) will be able to kick sand in the faces of those other universes that have been bullying it in the past.
    (b) will experience accelerated expansion.
    (c) will expand indefinitely.
    (d) will eventually stop expanding and re-collapse into a highly compact state.

89. If the average density of the universe is small enough, then the universe
    (a) will be able to take up gymnastics as a hobby.
    (b) will slow its expansion.
    (c) will expand indefinitely.
    (d) will eventually stop expanding and re-collapse into a highly compact state.

90. The observation that _____ led to the proposal and discussion of Olbers's paradox.

    (a) galactic rotation curves are not what is expected according to Kepler's laws
    (b) the expansion of the universe is accelerating
    (c) the rotation rate of pulsars decreases over time
    (d) the sky is dark at night

91. The fact that planets in the solar system all move roughly in the same plane and in the same direction supports

    (a) Carlsen's theory of alchemy.
    (b) Einstein's theory of general relativity.
    (c) the theory of Olbers's paradox.
    (d) Skinner's theory of *les boites*.
    (e) [None of the others.]

92. Each terrestrial planet in our solar system has a structure consisting of

    (a) rock, paper, and scissors.
    (b) earth, air, water, and fire.
    (c) core, mantle, and crust.
    (d) metal grid, land module, and atmosphere.
    (e) land, ocean, and atmosphere.

93. The International Astronomical Union decided in 2006 that Pluto should no longer be considered a planet because

    (a) it had repeatedly failed to pay its dues in the IAU Planetary Society.
    (b) Pluto is too small.
    (c) Pluto is too far from the Sun.
    (d) Pluto has not cleared its orbit.
    (e) [None of the above.]

94. Humans first set foot on the Moon in the year

    (a) 1776.
    (b) 1847.
    (c) 1969.
    (d) 2010.
    (e) [Humans have never set foot on the Moon.]

95. Humans first set foot on Mars in the year
    (a) 1776.
    (b) 1847.
    (c) 1969.
    (d) 2010.
    (e) [Humans have never set foot on Mars.]
96. Most meteorites that strike the Earth are
    (a) irons.
    (b) woods.
    (c) stones.
    (d) stony-woods.
    (e) stony-irons or irony-stones.
97. Short-period comets typically originate
    (a) in Ford factories of the 1960s.
    (b) in the Kuiper belt.
    (c) in the Oort cloud.
    (d) in the asteroid belt.
    (e) in the large Magellanic cloud.
98. Long-period comets typically originate
    (a) in Ford factories of the 1960s.
    (b) in the Kuiper belt.
    (c) in the Oort cloud.
    (d) in the asteroid belt.
    (e) in the large Magellanic cloud.
99. The atmosphere of Mercury is _____ Earth's atmosphere.
    (a) much denser than
    (b) about as dense as
    (c) slightly less dense than
    (d) [The atmosphere of Mercury is almost a vacuum.]
100. The greenhouse effect is a significant effect
    (a) only on the Earth.
    (b) on all terrestrial planets.
    (c) on planets that have atmospheres.
    (d) only on exoplanets.