BROCK UNIVERSITY

Final Exam: April 2017
Course: ASTR 1P02
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Time limit: 2 hours
Instructor: S. D'Agostino

Answer all questions on the scantron 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 scantron sheet when you leave the exam room.

DO NOT WRITE YOUR ANSWERS ON YOUR QUESTION PAGE. DOING SO WILL RESULT IN AN ASSIGNED GRADE OF ZERO.

1. Main sequence stars are in hydrostatic equilibrium, which is a balance between
   (a) outward hydro forces and inward equilibrium forces.
   (b) * outward gas pressure and inward gravitational force.
   (c) temperature and density.
   (d) photons and neutrinos.
   (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. Stellar models are
   (a) people like George and Amal Clooney.
   (b) models of stars that you might find at a planetarium.
   (c) models of stars that you might find at a science fair.
   (d) * computer programs that use the laws of physics to calculate what the detailed properties of a star might be, based on the star's mass and radius.

5. Hydrogen fusion is a process in which
   (a) hydrogen nuclei split, with a release of energy.
   (b) hydrogen nuclei are formed from constituent parts, with a release of energy.
   (c) * hydrogen nuclei join to produce heavier nuclei, with a release of energy.
   (d) hydrogen atoms undergo chemical reactions, with a release of energy.

6. The net result of a proton-proton chain reaction is that
   (a) two protons combine to produce a neutron and a neutrino with the release of radiant energy.
   (b) * four hydrogen nuclei combine to produce a helium nucleus with the release of neutrinos and radiant energy.
   (c) four hydrogen nuclei combine to produce protons with the release of neutrinos and radiant energy.
   (d) four protons combine to produce a hydrogen nucleus with the release of neutrinos and radiant energy.

7. Fusion reactions in a gas are rare unless the gas is extremely
   (a) cold.
   (b) * hot.
   (c) massive.
   (d) tenuous.
   (e) [None of the above.]

8. The temperature of the Sun's core is about
   (a) 15 K.
   (b) 15,000 K.
   (c) * 15,000,000 K.
   (d) 15,000,000,000 K.

9. Main-sequence stars with masses of about the Sun's mass or less primarily use _____ for their fusion reactions.
   (a) * the proton-proton chain
   (b) the CNO cycle
   (c) the Krebs cycle
   (d) the recumbent cycle
   (e) the SNO cycle

10. Main-sequence stars with masses much greater than the Sun's mass primarily use _____ for their fusion reactions.
   (a) the proton-proton chain
   (b) * the CNO cycle
   (c) the Krebs cycle
   (d) the recumbent cycle
   (e) the SNO cycle

11. Data collected over many years by the SNO in Sudbury, Ontario provided strong evidence for the standard theory of
   (a) the origin of the universe.
   (b) the evolution of the solar system.
   (c) * energy production in the Sun.
   (d) stellar nucleosynthesis.
   (e) giant supernovae explosions.

12. For main-sequence stars, the more massive a star is,
   (a) * the more luminous it is.
   (b) the less luminous it is.
   (c) [There is no relation between mass and luminosity for a main-sequence star.]

13. For the most part, protostars form
   (a) * deep inside clouds of dust and gas.
   (b) far away from any clouds of dust and gas.
   (c) within inter-galactic voids.
   (d) inside black-hole event horizons.

14. The dramatic changes that occur towards the end of a high-mass star's lifetime are initiated by
   (a) a balance of pressure and gravity resulting in hydrostatic equilibrium.
   (b) runaway convection in the star's atmosphere.
   (c) runaway chemical reactions in the star's core.
   (d) * the star's core running out of hydrogen.

15. If the mass of Star A is significantly greater than the mass of Star B, then
    (a) the lifetime of Star A is longer than the lifetime of Star B.
    (b) * the lifetime of Star A is shorter than the lifetime of Star B.
    (c) [A star's lifetime does not depend on its mass.]
16. Helium fusion in the core of a red giant star produces
    (a) hydrogen and lithium.
    (b) * carbon and oxygen.
    (c) uranium and plutonium.
    (d) iron and nickel.
    (e) [None of the above.]
17. A planetary nebula is a remnant of
    (a) a Type I supernova explosion.
    (b) a Type II supernova explosion.
    (c) the end-stage evolution of a high-mass star.
    (d) * the end-stage evolution of a medium-mass star.
18. Reflection nebulae are
    (a) * blue.
    (b) red.
    (c) white.
    (d) yellow.
19. Emission nebulae are
    (a) blue.
    (b) * red.
    (c) white.
    (d) yellow.
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 _____ then hydrogen fusion begins and the protostar becomes a main-sequence star.

    (a) 10 thousand degrees K
    (b) * 10 million degrees K
    (c) 10 billion degrees K
    (d) 10 trillion degrees K

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. The non-fusing core that remains immediately at the end of the lifetime of a medium-mass star is called a

    (a) * white dwarf.
    (b) red dwarf.
    (c) brown dwarf.
    (d) green dwarf.

24. The main-sequence lifetime of a star depends on its

    (a) mass and colour.
    (b) mass and spectrum.
    (c) mass and chemical composition.
    (d) * mass and luminosity.

25. If a collapsing star has a mass less than the Chandrasekhar limit, then it

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

26. White dwarfs typically have sizes that are approximately the size of

    (a) the Moon.
    (b) * the Earth.
    (c) Jupiter.
    (d) the Sun.

27. Eventually, a white dwarf will stop emitting light, but this is expected to take
    (a) several thousand years.
    (b) several million years.
    (c) several billion years.
    (d) * several trillion years.
28. The surface temperature of a white dwarfs is approximately
    (a) * tens of thousands of degrees.
    (b) hundreds of thousands of degrees.
    (c) millions of degrees.
    (d) tens of millions of degrees.
29. When rotating stars contract, their rotation rates typically
    (a) * increase.
    (b) decrease.
    (c) do not change.
30. A neutron star is a remnant of a
    (a) type Ia supernova.
    (b) * type II supernova.
    (c) type III supernova.
    (d) type IV supernova.
31. A black hole is a remnant of a
    (a) type Ia supernova.
    (b) * type II supernova.
    (c) type III supernova.
    (d) type IV supernova.
32. 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.

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

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

34. The famous SN1987A, discovered by Canadian astronomer Ian Shelton, is

    (a) a quasar.
    (b) a neutron star.
    (c) a black hole.
    (d) a Type Ia supernova.
    (e) * a Type II supernova.

35. A pulsar is a rotating

    (a) black hole.
    (b) * neutron star.
    (c) quasar.
    (d) white dwarf.
    (e) [None of the above.]

36. Precision measurements on binary pulsars have provided strong evidence for

    (a) * Einstein's theory of gravity.
    (b) Kepler's laws.
    (c) Newton's theory of gravity.
    (d) the Stefan-Boltzmann law.
    (e) Wien's law.

37. If the Sun were suddenly and magically replaced by a black hole of the same mass, then the planets in our solar system would

    (a) immediately be "vacuumed" into the black hole.
    (b) gradually spiral in and be consumed by the black hole.
    (c) escape the solar system by "flying off on tangents" to their orbits.
    (d) begin moving chaotically, much like the atoms in a cloud of gas.
    (e) * [No change in planetary motions would occur.]

38. Astronomers search for black holes by examining binary systems in which an invisible component has mass greater than 3 solar masses and is a strong emitter of

    (a) infrared radiation.
    (b) quasars.
    (c) radio waves.
    (d) ultraviolet radiation.
    (e) * X-rays.

39. It was first confirmed that separate galaxies existed outside our own Milky Way galaxy

    (a) by ancient Greek astronomers.
    (b) by medieval European astronomers.
    (c) in the eighteenth century.
    (d) * in the twentieth century.

40. With the aid of modern telescopes, the number of galaxies currently visible is in the

    (a) thousands.
    (b) millions.
    (c) * billions.
    (d) trillions.

41. Spiral 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.

42. Spiral 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.

43. Cosmological redshift is a result of

    (a) * space between galaxies expanding.
    (b) light moving away from massive stars.
    (c) the source of light moving rapidly towards us.
    (d) the gravitational lensing effect.

44. A common result of a galaxy collision is

    (a) the creation of one or more "child" galaxies.
    (b) the formation of black holes.
    (c) the dark matter in one galaxy absorbs dark energy from the other galaxy.
    (d) * gravitational distortion of one or both of the galaxies.

45. The period of the luminosity variation of a quasar provides insight into the quasar's

    (a) absolute luminosity.
    (b) density.
    (c) mass.
    (d) * size.

46. According to the Big Bang theory, _____ formed about 380 thousand years after the Big Bang.

    (a) ionized hydrogen atoms
    (b) * neutral hydrogen atoms
    (c) ionized hydrogen molecules
    (d) neutral hydrogen molecules

47. The Higgs boson was first detected

    (a) by the WMAP satellite in 2005.
    (b) by the Planck satellite in 2007.
    (c) by the COBE satellite in 2009.
    (d) * by the LHC in 2012.

48. One of the predictions of Einstein's theory of general relativity is that light from distant stars should have its path bent by

    (a) refraction through interstellar glasses, ices, and crystals.
    (b) scattering from interstellar gas and dust.
    (c) destructive interference due to the Doppler effect from giant black holes.
    (d) * the gravitational effect of matter between us and the source of the light.

49. Data from the WMAP and Planck satellite observatories suggest that the the universe

    (a) is flat (overall).
    (b) has accelerating expansion.
    (c) will probably expand forever.
    (d) * [All of the above.]
    (e) [None of the above.]

50. In the first minute or so after the Big Bang, atomic nuclei could not exist because

    (a) * it was too hot.
    (b) stars had not yet formed.
    (c) galaxies had not yet formed.
    (d) the density of quasars was too high.
    (e) [None of the above.]

51. We can observe the centre of the Milky Way galaxy using

    (a) visible light.
    (b) * radio waves.
    (c) satellite exploration.
    (d) [None of the above.]
    (e) [Both (a) and (b).]

52. The amount of ordinary matter in the universe is currently thought to be _____ the amount of dark matter.

    (a) much greater than
    (b) about the same as
    (c) * much less than
    (d) [We currently have no idea about this.]

53. The Milky Way is

    (a) an active galaxy.
    (b) * a spiral galaxy.
    (c) an elliptical galaxy.
    (d) an irregular galaxy.
    (e) [None of the above.]

54. About _____ of the mass of the solar system is contained in the Sun.

    (a) 50%
    (b) 65%
    (c) 80%
    (d) * 99.9%

55. The mass of the Sun is about _____ times the mass of the Earth.

    (a) 100
    (b) 300
    (c) 100,000
    (d) * 300,000

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 terrestrial planets are _____ than the Jovian planets.

    (a) * smaller
    (b) larger

58. The terrestrial planets are _____ the Jovian planets.

    (a) less dense than
    (b) about as dense as
    (c) * more dense than

59. The terrestrial planets are typically _____ than the Jovian planets.

    (a) * warmer
    (b) colder

60. The orbits of the planets around the Sun lie

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

61. The planet _____ rotates "backwards" compared to the other planets.

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

62. The planet _____ rotates "on its side" compared to its orbital motion.

    (a) Jupiter
    (b) Saturn
    (c) * Uranus
    (d) Neptune
    (e) [None of the above.]

63. The ages of rocks found in the solar system are often determined by using the properties of

    (a) homoclinic stochasticity.
    (b) magnetic susceptibility.
    (c) nuclear magnetic resonance.
    (d) * radioactive elements.
    (e) [None of the above.]

64. The chemical composition of the Sun's atmosphere is _____ the chemical composition of the solar nebula.

    (a) * very similar to
    (b) very different from

65. The cores of terrestrial planets are primarily composed of

    (a) hydrogen and helium.
    (b) * iron and nickel.
    (c) molten lava.
    (d) rock.

66. The outer planets have a much higher concentration of _____ than the inner planets.

    (a) * hydrogen.
    (b) iron.
    (c) silicon.
    (d) uranium.

67. The age of the planets is about

    (a) 50 million years.
    (b) 500 million years.
    (c) * 5 billion years.
    (d) 50 billion years.

68. The process by which small solid particles stick together to form larger particles, as part of the formation of planetesimals, is known as

    (a) * accretion.
    (b) differentiation.
    (c) integration.
    (d) sublimation.

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

    (a) cars that were driven on the planet Mercury in the 1960s.
    (b) snowballs ejected from the underworld.
    (c) * chunks of frozen gases with solid particles mixed in.
    (d) rocks that have broken off from planets.

71. Small chunks of rock that have landed on Earth after coming from outer space 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 fly through the solar system are called

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

74. The Chicxulub crater is

    (a) one of the hottest new clubs in the Sector 8 Void.
    (b) one of the most prominent craters on the Moon.
    (c) one of the largest craters on Mars.
    (d) * a large crater on Earth that is associated with the extinction of the dinosaurs.
    (e) [None of the above.]

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

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

76. 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.]

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 largest mountain in the solar system is on the surface of

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

79. Rings are found around

    (a) only the planet Saturn.
    (b) Jupiter and Saturn.
    (c) Jupiter, Saturn, and Uranus.
    (d) * Jupiter, Saturn, Uranus, and Neptune.
    (e) [None of the above.]

80. The mass of the Milky Way galaxy is determined by carefully measuring

    (a) * motions of the stars within the galaxy.
    (b) stellar spectra of stars in nearby galaxies.
    (c) parallaxes of stars in binary clusters.
    (d) entropies of nebulae in the Milky Way's disk.
    (e) [None of the above.]

81. MACHOs and WIMPs are hypotheses intended to explain

    (a) black hole thermodynamics.
    (b) galactic clustering.
    (c) dark energy.
    (d) * dark matter.

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

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

83. The historical significance of Hubble's law is that it helped to establish the fact that

    (a) black holes have event horizons.
    (b) Kepler's laws of planetary motion are also valid elsewhere in the Milky Way galaxy.
    (c) both red shifts and blue shifts are possible in stellar spectra.
    (d) * galaxies are generally moving away from each other.

84. The following observed properties of cosmic microwave background radiation provide strong evidence for the Big Bang theory of the formation of the universe.

    (a) its mass and density
    (b) its pressure and volume
    (c) * its temperature and similarity in all directions
    (d) its tension and diameter

85. The cosmic microwave background radiation was first observed

    (a) by ancient astronomers.
    (b) in the 1300s.
    (c) in the 1500s.
    (d) in the 1700s.
    (e) * in the 1900s.

86. Observed fluctuations in the cosmic microwave background are currently _____, which implies that matter was almost uniformly distributed in the early years after the Big Bang.

    (a) * tiny
    (b) enormous
    (c) [Such fluctuations have never been observed.]

87. The current temperature of the cosmic microwave background radiation is approximately

    (a) * 3 K.
    (b) 30 K.
    (c) 300 K.
    (d) 3000 K.

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 latest observations on the overall curvature of the universe suggest that the universe

    (a) * is nearly flat.
    (b) is very strongly positively curved, like a sphere or egg.
    (c) is very strongly negatively curved, like a saddle.
    (d) has a large number of wormholes.

91. The tail of a comet is gas and dust

    (a) pulled off the comet by the Sun's gravity.
    (b) pulled off the comet by friction with the inter-planetary medium.
    (c) * pushed off the comet by the Sun's heat and radiation pressure.
    (d) pushed off the comet by nuclear fusion in the comet's nucleus.

92. The bright streak of light seen when a small object from the solar system flies through the atmosphere is caused by

    (a) sunlight reflected from the object.
    (b) moonlight reflected from the object.
    (c) radioactive decay of material in the object.
    (d) * frictional heating.

93. The source of most meteorites is

    (a) asteroids.
    (b) * comets.
    (c) Mars.
    (d) material from the solar wind.
    (e) the Moon.

94. Most asteroids in the main asteroid location of the solar system have orbits that are

    (a) * prograde, nearly circular, and near the ecliptic.
    (b) prograde, highly elliptical, and near the ecliptic.
    (c) retrograde, nearly circular, and near the ecliptic.
    (d) retrograde, highly elliptical, and might be near or far from the ecliptic.

95. The average spacing between asteroids in the main asteroid location of the solar system is about

    (a) 10 m.
    (b) 1 km.
    (c) 1 thousand km.
    (d) * 1 million km.

96. Asteroids in the asteroid belt are made up of

    (a) iron.
    (b) silicates (rock).
    (c) organic compounds.
    (d) * [All of the above.]

97. Most meteorites that strike the Earth are

    (a) irons.
    (b) woods.
    (c) * stones.
    (d) stony-irons.

98. The nucleus of a comet resembles

    (a) a harbinger of doom.
    (b) a muddy baseball.
    (c) a sticky tarball.
    (d) * a dirty snowball.

99. Most comets originate

    (a) in Ford factories of the 1960s if they have long periods and in used car lots if they have short periods.
    (b) * in the Kuiper belt if they have short periods and in the Oort cloud if they have long periods.
    (c) in the Kuiper belt if they have long periods and in the Oort cloud if they have short periods.
    (d) in the Bermuda triangle if they have short periods and in the Costa del Sol if they have long periods.

100. Concerning planets orbiting other stars besides our Sun,

    (a) none have ever been observed, and there is no evidence for them yet.
    (b) * many have been observed, and research is ongoing.
    (c) there is indirect evidence for them, but there have been no definitive discoveries yet.